SUGARBEET RESEARCH

1999 REPORT

FOREWORD

SUGARBEET RESEARCH is an annual compilation of progress reports concerning research by U. S. Department of Agriculture, Agricultural Research Service investigators and other cooperators who are engaged in sugarbeet research. The report was assembled and produced at the expense of the Beet Sugar Development Foundation, and is for the sole use of its members and the cooperators. Much of the data has not been sufficiently confirmed to justify general release and interpretations may be modified with additional experimentation. This report is not intended for publication and should not be used for cited reference nor quoted in publicity or advertising. Reproduction of any portion of the material contained herein will not be permitted without the specific consent of the contributor and the Beet Sugar Development Foundation.

The report presents results of investigations strengthened by contributions received under Cooperative Agreement between the USDA Agricultural Service and the Beet Sugar Development Foundation, along with the California Beet Growers Association, the Western Joint Research Committee, the Sugarbeet and Education Board of Minnesota and North Dakota, and Texas A & M University.

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SUGARBEET RESEARCH

1999 REPORT

Section A

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ABSTRACTS OF PAPERS PUBLISHED OR APPROVED FOR PUBLICATION, 1999

LEWELLEN, R.T. Registration of Multiple Disease Resistant C69 Sugarbeet Germplasm. Crop Sci. 40 (in press).

Sugarbeet (*Beta vulgaris* L.) germplasm line C69 (PI599341) was developed by the USDA-ARS in cooperation with the Beet Sugar Development Foundation and the California Beet Growers Association. This line was released in 1997. C69 is a vigorous, multigerm, self-sterile line with tolerance to virus yellows (VY) and segregates for resistance to rhizomania conditioned by *Rz*. Tolerance to VY is to beet western yellows, beet chlorosis, and beet yellows viruses, but resistance to the luteoviruses, beet western yellows and beet chlorosis, is stronger. The VY tolerance was derived from nearly the entire germplasm base of the long term USDA-ARS VY resistance breeding program at Salinas, CA. The *Rz* allele was from lines C78, C79, C80, and C82 that were developed by backcrossing *Rz* into C46, C37, C54, and C31, respectively. Plants selected for resistance to rhizomania caused by beet necrotic yellow vein virus within lines C78, C79, C80, and C82 were bulked and used as the pollinator in a composite cross made in a field seed plot to rhizomania susceptible stecklings combined from lines C31/6,C39, C46/2, C47, C49, C54, C91, C92, Y48, Y56, and Y57. Plants selected for resistance to rhizomania from this composite cross were bulked and used to pollinate a composite of stecklings with green hypocotyls from breeding lines C31/6, C31-43, C31-89, C39, C49, and C91. Both red hypocotyl color and resistance to rhizomania were used as markers to identify F_1 plants from this second composite cross. The inter se increase of 71 F_1 plants produced a broadly-based line called Y569. Y569 is expected to be predominantly composed of the germplasm of C31 with smaller amounts of C37, C46, C39, C64, and other sources.

Y569 was planted under moderately severe rhizomania conditions at Salinas. The plants in the selection plot were inoculated with sugarbeet *Erwinia* [*E. carotovora* (Jones) Bergey subsp. *betavasculorum*]. Powdery mildew caused by *Erysiphe polygoni* DC and Cercospora leaf spot caused by *C. beticola* Sacc. were not controlled and were moderate on susceptible plants. A high incidence of natural infection with beet western yellows virus occurred. Phytophthora tip rot caused by *P. dreschleri* Tucker was prevalent and differentially damaged breeding lines in this planting. In late November, individual plants were selected based upon root yield, beet conformation, and resistance to rhizomania, root rots, Cercospora leaf spot, and powdery mildew. Roots visually selected in the field were reselected for sucrose concentration. Following vernalization, 39 (about 2% of initial population) mother roots were increased in mass to produce breeding line Y769. Line Y769 was reselected for resistance to rhizomania to produce germplasm C69.

Preliminary tests show that C69 has relatively high sucrose concentration, good root and agronomic traits, large canopy, and combined disease resistance. Segregation for reaction to rhizomania occurs. This line has high resistance to *Erwinia* and moderate resistance to VY and powdery mildew. In tests under VY inoculated conditions, C69 had higher sugar yield than any

breeding line or commercial hybrid in the trials. It is a moderately nonbolting type. Line C69 is moderately susceptible to curly top virus. It has higher sucrose concentration than C78 or C80. Line C69 should be useful as a broadbased source for continued population improvement and from which parental lines with combined resistance could be extracted.

LEWELLEN, R.T. Registration of Powdery Mildew Resistant Sugarbeet Germplasms CP01 and CP02. Crop Sci. 40 (in press).

Sugarbeet (*Beta vulgaris* L.) germplasm lines CP01 (PI610490) and CP02 (PI610491) were developed by the USDA-ARS in cooperation with the Beet Sugar Development Foundation and the California Beet Growers Association. These lines were released in 1999. CP01 and CP02 are self-sterile, multigerm, germplasm lines that segregate for resistance to powdery mildew caused by *Erysiphe polygoni* DC (syn. *E.betae* Weltzien). CP01 and CP02 have identical developmental histories except for the source of resistance to powdery mildew. Resistance within CP01 was from WB97 (PI546394) and within CP02 was from WB242 (PI546413). High resistance to powdery mildew within these *B. vulgaris* L. subsp. *maritima* (L.) Arcang. accessions was identified separately by McFarlane and Whitney at Salinas, CA. Seed of WB97 was sent to Salinas from the Japan Sugarbeet Improvement Foundation in 1968. Passport information indicated that it was sent to Japan from Wageningen, the Netherlands as WB46 (*B.patula* Ait.) in 1963. The site of its original collection is not known. If WB46 is *B.patula*, then it would have been collected from Ilheu dos Embarcaderos near Madeira. Seed of WB242 was obtained from IRS, Bergen op Zoom, the Netherlands, in 1974 as a *B. vulgaris* subsp. *maritima* line originally collected in the Loire River Estuary in France. WB242 also is known to have low sugarbeet cyst nematode (SBCN) *Heterodera schachtii* Schmidt counts and may be the same or similar to wild beet lines known as Le Pouliguen Group 2 and to PI198758 and PI198759. When grown at Salinas, WB242 is variable for plant type, root and stem pigmentation, bolting habit, and root type. Most plants of both WB97 and WB242 have red hypocotyls and stems and are annual. Both are susceptible to rhizomania caused by beet necrotic yellow vein virus.

In order to enhance sugarbeet with the high resistance to powdery mildew found in WB97 and WB242 and to study the inheritance of powdery mildew resistance, powdery mildew resistance was backcrossed into sugarbeet breeding line C37 that has resistance to curly top, virus yellows, *Erwinia* sp. and bolting. C37 is highly susceptible to powdery mildew, completely self-sterile under Salinas greenhouse conditions, and has green hypocotyls. These traits facilitated making and recognizing the F_1 hybrids in each generation. Resistance from WB97 and WB242 was transferred in separate but parallel sets of crosses. Usually C37 was used as the female parent so CP01 and CP02 have sugarbeet cytoplasm. CP01 and CP02 initially were released as the BC_4F_2 generation. BC_4F_1 testcross families of these lines were evaluated in the field in 1997 and segregated for reaction to powdery mildew. Unselected stecklings of these BC_4F_1 testscrosses were increased in mass to produce lines P813 and P814 that were released as CP01 and CP02, respectively. Genetic studies in 1997 and 1999 indicated that resistance to powdery mildew is inherited in the manner of a single dominant allele in each of these wild beet sources. This resistance has tentatively been assigned the *Pm* gene symbol. Allelism between the WB97 and WB242 resistances has not been determined.

CP01 and CP02 are susceptible to rhizomania. Likewise, they should be similar to the C37 recurrent parent for other traits. Some of the BC_4F_1 testcrosses segregated for annualism so this trait remains in these lines. No attempt has been made to determine if any variability for SBCN resistance remains from WB242. CP01 and CP02 should be useful as enhanced sources of resistance to powdery mildew originally found in *B.vulgaris* subsp. *maritima* and for genetic research. Preliminary tests have tentatively identified molecular markers specific for powdery mildew resistance from WB242.

OBERMEIER, C., J.L. SEARS, G.C. WISLER, H.Y. LIU, K.O. SCHLUETER, E.J. RYDER, J.E. DUFFUS, and S.T. KOIKE. 1999. Characterization of a new tomato bushy stunt-related tombusvirus associated with lettuce dieback disease in California. Phytopathology 85:S57.

A disease causing dieback of Romaine lettuce has been found increasingly in California. Affected lettuce plants exhibit severe stunting, chlorosis and necrosis of older leaves. Plants infected early in their development may die. An isometric virus has been isolated consistently from roots and leaves of symptomatic lettuce plants. Particles are 30 nm in diameter. Double-stranded RNA profiles are identical to those of TBSV isolates. Cloning of the 3í-terminus of the viral genomic RNA revealed 84% to 88% nucleotide sequence identity with several TBSV strains. RT-PCR has been successfully applied for detection of the virus in lettuce leaves. Field trials revealed no resistance in Romaine, but did show resistance in several leaf and crisphead lettuce varieties. Although inoculation under greenhouse conditions has not yet reproduced the dieback disease in lettuce, the consistent isolation of this TBSV-related virus from field-grown symptomatic lettuce suggests that it may be the cause of the disease.

WEILAND, J.J. and R.T. LEWELLEN. Generation of Molecular Genetic Markers Associated with Resistance to Powdery Mildew (*Erysiphe polygoni* DC) in Sugarbeet (*Beta vulgaris* L.). 9th Int'l Congress, July 1999. International Soc. Plant-Microbe Interactions. p. 215

Powdery mildew caused by *Erysiphe polygoni* DC can be devastating to sugarbeet production particularly in warm, dry climates. Although resistance to certain races of *E.polygoni* exists in sugarbeet, powdery mildew disease is typically controlled through the use of fungicides. The identification of broad resistance to sugarbeet powdery mildew in the wild beet *B.vulgaris* spp. *maritima* was followed by the incorporation of this resistance into sugarbeet by recurrent backcrossing and progeny testing. Germplasm accession C37 was used as the susceptible, recurrent parent and P604 is the F_2BC_3 population at the intermediate stage of the introgression. Three DNA pools each were produced for C37 and P604; each pool was comprised of the DNA from 7 individual plants. A diprimer adaptation of the RAPD analysis was applied to the DNA pools, where one of the primers was composed of a sequence homologous to that encoding a core sequence found in many plant disease resistance genes. Amplified products were identified that were associated with all three DNA pools derived from P604 plants, but with none of the three DNA pools derived from C37. The possibility that some of the amplified products contain sequences of the gene conferring resistance to sugarbeet powdery mildew is discussed.

WINTERMANTEL, W.M. and J.L. SEARS. 1999. Examination of viral interactions in relation to disease severity and resistance in the virus yellows complex of sugarbeet. Phytopathology 89:S85.

Virus yellows is a disease complex composed of different genera of plant viruses. Beet yellows closterovirus (BYV), beet western yellows luteovirus (BWYV), and occasionally, beet mosaic potyvirus (BtMV), are the main components. BtMV alone may not contribute to economically significantly disease loss. All of these viruses are transmitted by aphids, and all are usually present at some level in infected fields. Although beet-free periods are useful in managing virus yellows, the increased range and population of the black bean aphid has made this disease more difficult to control in recent years. In this study, sugarbeet varieties exhibiting differential levels of resistance to the yellows complex viruses were inoculated with every possible combination of one, two or all three viruses. Interviral effects were identified and correlated using quantitative molecular techniques. Correlation of stunting and symptom severity with different virus combinations indicate that disease is more severe when all three viruses are present than when plants are infected by one or any combination of two viruses.

WINTERMANTEL, W.M. AND M. ZAITLIN. 2000. Transgene translatability increases effectiveness of replicase-mediated resistance to Cucumber mosaic virus. J. Gen. Virol. 81, 587-595.

Transgenic tobacco plants expressing an altered form of the 2a replicase gene from the Fny strain of cucumber mosaic virus (CMV) exhibit suppressed virus replication and restricted viral movement when inoculated mechanically or by aphid vectors. Additional transformants have been generated which contain replicase gene constructs designed to determine the role(s) of transgene mRNA and/or protein in resistance. Resistance to systemic disease caused by CMV, as well as delayed infection, was observed in several lines of transgenic plants which were capable of expressing either full length or truncated replicase proteins. In contrast, among plants which contained nontranslatable transgene constructs, only one of sixty-one lines examined exhibited delays or resistance. Once infected, plants never recovered, regardless of transgene translatability. Transgenic plants exhibiting a range of resistance levels were examined for transgene copy number, mRNA and protein levels. Although ribonuclease protection assays demonstrated that transgene mRNA levels were very low, resistant lines had consistently more steady-state transgene mRNA than susceptible lines. Furthermore, chlorotic or necrotic local lesions developed on the inoculated leaves of transgenic lines containing translatable transgenes, but not on inoculated leaves of lines containing nontranslatable transgenes. These results demonstrate that translatability of the transgene and possibly expression of the transgene protein itself facilitates replicase-mediated resistance to CMV in tobacco.

WISLER,G.C., R. T. LEWELLEN, W. M. WINTERMANTEL, H-.Y. LIU, and J. S. SEARS. 1999. Differences Among Sugarbeet Cultivars with Varying Levels of Rhizomania Resistance To Single And Mixed Infections with BNYVV and BSBMV. Proc. Fourth Symposium of the International Working Group on Plant Viruses with Fungal Vectors. 135-138.

Eight sugarbeet cultivars, that range in reaction to rhizomania from uniformly susceptible to highly resistant, were compared for levels of beet necrotic yellow vein benyvirus, as measured by TAS-ELISA in field studies in Salinas, California. Differences in absorbance ($A_{405\,nm}$) values measured among the cultivars closely correlated with the dosage and frequency of the *Rz* allele that conditions resistance to BNYVV. Absorbance values were significantly positively correlated with rhizomania disease index scores and negatively correlated with individual root weight, plot root weight, and sugar yield. The same eight cultivars were compared in greenhouse pot cultures for their reactions to beet soil-borne mosaic benyvirus. All cultivars were highly susceptible to BSBMV, with absorbance readings ranging from 8 to 12 times the healthy root mean. When mixed infections of BNYVV and BSBMV were compared to single infections in a susceptible and resistant sugarbeet line, the reactions, as measured by root symptoms and individual beet weight were significantly more severe than each virus alone. This was true regardless of whether the seedlings were initially infested with either BNYVV or BSBMV. Thus, resistance to BNYVV does not confer resistance to BSBMV, nor does BSBMV infection moderate the effects of BNYVV.

WISLER, G.C., J. L. SEARS, H.-Y. LIU, C. OBERMEIER, and J. E. DUFFUS. 1999. A new disease of greenhouse-grown tomatoes caused by tomato bushy stunt virus (TBSV). Phytopathology 89:S85.

A previously undescribed disease of hydroponic, greenhouse-grown tomatoes was detected in the Central United States. Symptoms include stunting of affected plants, leaf necrosis, fruit and flower drop, and truss necrosis. Although fruit appears to be normal, the stem end shows a ring of necrosis after the calyx is removed, and the internal part of the fruit shows necrosis that is primarily restricted to the vascular tissues. TBSV has been consistently isolated from symptomatic foliage, trusses and fruit. No fungal or bacterial organism has been isolated from symptomatic tissues. Virus particles measure 30 nm in diameter. The dsRNA profile is identical to those of known TBSV isolates. Koch's postulates were completed by pouring inoculum, increased in *Nicotiana benthamiana* from single local lesions, into 10 cm pots with tomato 'Trust' seedlings. Foliage and truss necrosis was produced by this method, and TBSV was re-isolated from affected tissues. Based on the unique fruit symptoms observed, this may be a different isolate or strain of TBSV than previously identified in tomato.

YU, M.H. Root-knot nematodes in California and the development of resistant sugarbeet varieties. Proc. Agric. Am. Soc. Sugar Beet Technol. p. 167-173. 1999.

The status of root-knot nematode distribution in California sugarbeet fields was investigated. Samples of the galled plants and infested soil were collected from various major growing areas. To identify the specificity of *Meloidogyne* spp., nematodes were initially recovered with the use of susceptible hosts. Matured females and egg masses were extracted from infected plants and inoculated to individual tomato seedlings that were growing in cone-tainers; for nematodes from infested soil, seedlings were germinated directly in pots containing the field soil to induce galling. Isolates recovered from these procedures were increased to build populations. They were then inoculated to groups of test plants for the 'differential host assay'. The results

indicated that the four most common species of root-knot nematode, i.e., *M. incognita, M. javanica, M. arenaria,* and *M. hapla,* were currently existent in California sugarbeet growing areas, occurring in eleven or more counties. Genetic sources of resistance to root-knot nematode is now available. Due to its multi-species resistance capability, sugarbeet production may be protected from serious root-knot nematode damages when the resistance is eventually incorporated into a commercial variety.

YU, M.H., W. HEIJBROEK and L.M. PAKISH. The sea beet source of resistance to multiple species of root-knot nematode. Euphytica 108: 151-155. 1999.

Development of commercially available host-plant resistance to *Meloidogyne* spp. is essential to sugarbeet (*Beta vulgaris* L.) root-knot nematode resistance breeding. Reactions of seedlings from resistant crosses and hybrid derivatives were evaluated against juvenile (J2) inoculations in the greenhouse. The noncultivated sea beet [*B. vulgaris* ssp. *maritima* (L.) Arcang] source of resistance is effective against the four economically important root-knot nematodes, i.e., *M. incognita* Races 1, 2, and 4 (Race 3 not tested), *M. javanica, M. arenaria* Races 1 and 2, and *M. hapla*. In monoxenic culture, *M. arenaria* inoculations resulted in the most galling, and *M. hapla*, the least. Species combinations induced higher rates of infection. Different races of the same *Meloidogyne* species caused similar galling. Preliminary inoculation studies indicated that resistance was also effective to *M. chitwoodi* and *M. fallax*. The trait of resistance to multiple *Meloidogyne* species may be valuable in developing sugarbeet, and possibly transgenic lines of other crops, resistant to root-knot nematode.

Project 281

Evaluation of BNYVV and BSBMV Concentrations and Effects of Rhizomania Resistant and Susceptible Sugarbeet Varieties

G. C. Wisler, R. T. Lewellen, W. M. Wintermantel, H.-Y. Liu, and J. E. Duffus

Rhizomania continues to be an important disease problem for the sugarbeet industry. Our research program regarding the detection and differentiation of *Beet necrotic yellow vein virus* (BNYVV), the cause of Rhizomania, and related soil-borne viruses belonging to the same genus *Benyviridae*, (formerly the Furovirus group) has made significant contributions over the past several years. A member of this family of viruses, termed *Beet soil-borne mosaic virus* (BSBMV), has received an increasing amount of attention due to the fact that it is serologically related to BNYVV. This has caused problems in certain serological tests due to low levels of cross-reactivity. Initial research on this particular project began in 1993 where five BNYVV isolates and eight BSBMV isolates from the United States were compared using serological, molecular and biological tests. It was concluded from these tests that all BNYVV isolates in the United States are virtually identical to one another. In addition, all BSBMV isolates, although serologically identical to one another, differ in plant host reactions and molecular properties. Another important conclusion drawn from this research was that BNYVV was shown to be clearly distinct from BSBMV, and BSBMV was determined to be a distinct benyvirus. These results have been repeatedly confirmed by additional tests in our lab for the past six years and more recently by others.

There are several highly sensitive diagnostic tests on the market today due to the massive screening programs developed for HIV. These tests are based on amplification of portions of the viral genome [by reverse transcriptase-polymerase chain reaction (RT-PCR)] followed by light activated molecular labels that are measured by sensitive equipment. However, these systems are not generally applicable to agricultural research due to the extreme expense of this technology. We have evaluated both amplification of the BNYVV genome by RT-PCR and subsequent detection with labeled molecular probes. We have evaluated several different variations of these methods and compared them to ELISA for BNYVV diagnosis. We have made significant improvements in the ELISA technique based on (1) production of antisera to the cloned coat protein of BNYVV, which provides a long-term supply of identical protein for future immunizations, and (2) using it in a triple-antibody sandwich ELISA in combination with a monoclonal antibody. This modified ELISA significantly improves the test by eliminating the cross-reaction, which was seen between BNYVV and BSBMV, and increases the sensitivity by adjusted concentrations of reagents. This test is now being marketed by Agdia, Inc. (Elkhart, Indiana). Thus, for the purpose of sensitive and specific identification of Rhizomania from soil samples, the TAS-ELISA, which is available from Agdia, is the best choice at this time.

Our studies on the BSBMV isolates of sugarbeet in the United States has suggested that this virus is responsible for some significant yield losses in areas that are infested. Because we have never detected BSBMV in California, we have to study this virus in other states where it is prevalent, or in greenhouses at the USDA in Salinas. BSBMV has been found in several locations in Colorado, Nebraska and Minnesota. In last year's Blue Book we reported results from 27 fields in Colorado and Nebraska where a significant decline in yield has been experienced by growers for the past few years. In that study, no fungal or bacterial pathogen was

found in any sample, and soil analyses indicated normal levels of nutrients, pH, etc. However, 24 of 27 fields were found to be infested with either BSBMV, *Beet soil-borne virus* (BSBV, another benyvirus member), or both. Only one field was found to be infested with Rhizomania. Although we do not know the exact cause of this yield decline, the association of low yields with these viruses which we know (from greenhouse studies) to be the cause of reduced growth of beets, suggests that we should pursue this line of research. This year we performed a small variety trial in Nebraska where half the plot was fumigated. Although the field had very low levels of BNYVV and BSBMV, a trend was observed where the fumigated section of the field had increased yields and sugar (see Western Sugar annual report). Studies in the past year have focused on determining if the series of Rhizomania resistant varieties used in the previous year's report show any resistance to BSBMV. We did not expect this to be the case, since BNYVV and BSBMV are distinct viruses and resistance would not normally be conferred to more than one virus unless they were considered to be strains or isolates of one another. The varieties used in this test are listed in Table 1. Results from last year's study showed: (1) differences in absorbance values for BNYVV measured by TAS-ELISA among the eight cultivars were closely correlated to the dosage and frequency of the *Rz* allele that conditions resistance to BNYVV, (2) the diploid *Rzrz* hybrid Beta4776R had a significantly lower value than the similar triploid *Rzrzrz* hybrid Beta4038R, and (3) cultivars that segregated *Rzrz:rzrz* (i.e., SS-781R and 6921H50) had higher absorbance values than the uniformly resistant *Rzrz* hybrids Beta4776R and HM7072. We also found that the virus titers (concentrations) in infected beets declined throughout the season. Therefore, sampling early in the season gives the best estimate of the disease incidence in the field.

Table 1. Sugar beet hybrids evaluated in rhizomania experiments; Salinas, California, 1997 growing season

Identification	Source	Description	Genotype
USH11	USDA-ARS	diploid susceptible	*rzrz*
KWS6770	Betaseed	triploid susceptible	*rzrzrz*
Beta4776R	Betaseed	diploid resistant	*Rzrz*
SS-781R	Spreckels	diploid segregating	*Rzrz:rzrz*
Rival	Holly	diploid resistant	*Rzrz*
HM7072	Novartis	diploid resistant	*Rzrz*
Beta4038R	Betaseed	triploid resistant	*Rzrzrz*
6921H50	USDA-ARS	diploid segregating	*B. maritima* hybrid

The same eight varieties that were used in the Rhizomania field study were also used in greenhouse studies to evaluate their possible resistance to BSBMV. Soil was obtained from fields that had been previously tested and were infested with BSBMV only. All eight varieties showed high BSBMV readings in DAS-ELISA in BSBMV soils (Fig. 1). Thus, it appears that resistance to BNYVV does not confer resistance to BSBMV.

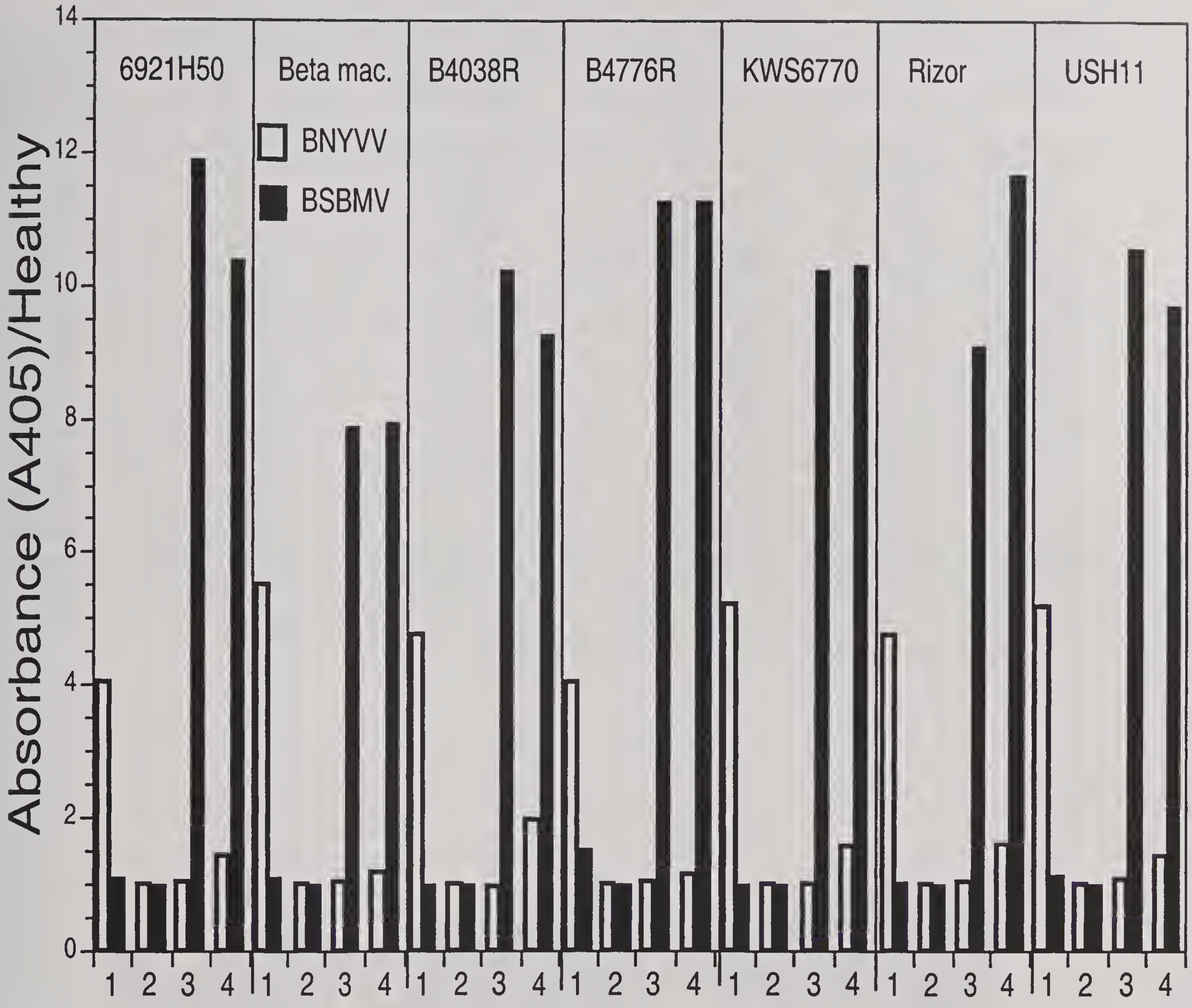


Fig. 1.

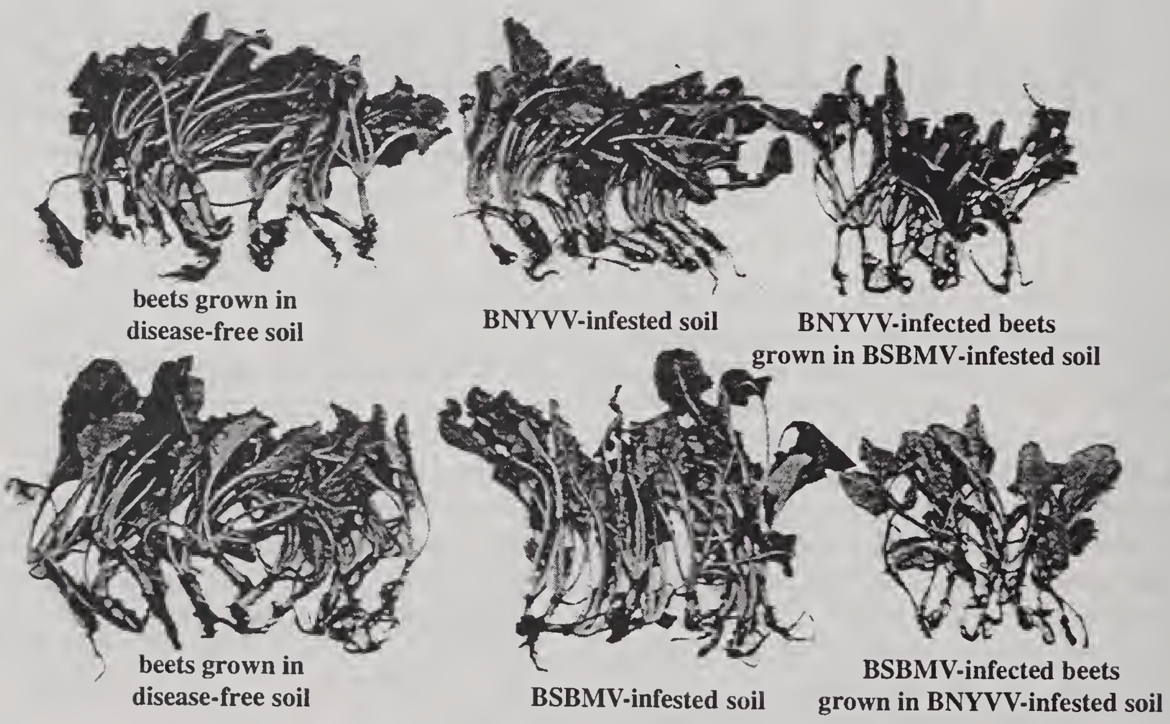
Cultivars USH-11 and B4776R were planted in greenhouse studies to determine the effect of mixed infections of BNYVV and BSBMV in sugar beets. Seed was first planted into (i) healthy soil, or soil infested with either (ii) BNYVV, or (iii) BSBMV. After six weeks they were tested for each virus, then transplanted into the respective soil; healthy, BNYVV- or BSBMV-infested. After an additional six weeks, plants were tested again for BNYVV and for BSBMV evaluated for symptoms and roots were weighed (Fig. 2). Only those beets that were infected with BNYVV showed blackened roots. Otherwise, the beets infected with BSBMV only were reduced in weight. Other than general yellowing, no leaf symptoms were observed for either virus. Depending on the variety used, the effect of mixed infections ranged from a 30% fresh weight reduction to an 81% reduction (Table 2). This study shows that under conditions of mixed infections in the soil, neither virus appears to moderate the infection of the other.

Table 2. Results from Cross-inoculation Experiments; Salinas, California, 1999.

Variety	Seedlings	Soil Transplanted Into	Mean fresh wt. (10 beets)	BNYVV TAS-ELISA (OD/Healthy)	BSBMV TAS-ELISA (OD/Healthy)
B4776R[c]	healthy	healthy	101.3g[a]	1.00[b]	0.976
B4776R	BSBMV	healthy	76.1	1.03	0.964
USH-11[c]	healthy	healthy	71.22	1.66	1.000
USH-11	BSBMV	healthy	66.7	0.99	0.960
B4776R	BNYVV	healthy	63.6	4.18	1.028
B4776R	healthy	BSBMV	38.97	1.14	3.788
B4776R	healthy	BNYVV	38.35	2.65	0.996
B4776R	BNYVV	BSBMV	29.14	2.87	4.088
B4776R	BSBMV	BNYVV	25.84	3.03	1.108
USH-11	healthy	BNYVV	24.74	4.75	0.968
USH-11	healthy	BSBMV	23.84	1.16	4.064
USH-11	BSBMV	BNYVV	23.72	4.80	1.120
USH-11	BNYVV	BSBMV	18.56	5.33	1.936
USH-11	BNYVV	healthy	9.48	2.03	1.432

[a] samples are listed in order by weight.
[b] Absorbance values are from the second six week transplant period.
[c] USH-11 typically has a lower yield than B4776R.

Fig. 2



Our studies of BNYVV and BSBMV clearly show that both viruses have a significant deleterious effect on the growth of beets. However, whereas BNYVV causes classic Rhizomania symptoms of root necrosis, bearding, reduced sugar and reduced yield, BSBMV does not induce Rhizomania. Far less is known about the effects of BSBMV of sugarbeet crops, except for the fact that reduced yield is expected to occur. Root necrosis is not evident in BSBMV-infected roots in greenhouse experiments using infested soil. Future studies will examine sugarbeet varieties for relative concentrations of BNYVV, BSBMV, and BSBV. We will conduct greenhouse and field trials to estimate effects of these viruses on yield and agronomic traits. Our studies will also attempt to determine if the Rhizomania resistance gene (*Rz*) to BNYVV has any effect upon the infection and impact of other benyviruses. Through greenhouse and field trials, we will determine if the poor performance experienced in some fields and production regions is due to non-BNYVV benyviruses. We will continue to investigate the existence of other soil-borne virus components in the "beet decline" syndromes which have occurred in Nebraska and Colorado. Because Rhizomania and other benyviruses are present in most beet growing regions in the United States, we will conduct greenhouse and field studies to determine the effect of mixed infections on beet performance, and measure their relative levels, compared to single infections. Preliminary evidence suggests that the combination of BNYVV and BSBMV is more severe than either virus alone. This again emphasizes the need for the development of resistance to other soil-borne benyviruses aside from BNYVV.

Western Sugar Company-Grower Joint Research Committee Report. Part I: Investigations into the cause for decreased yield and sugar yield in midwestern sugar beet production.

G.C. Wisler

Introduction

A significant decrease in sugarbeet yield has been observed throughout the Eastern Slopes of the United States for the past few years. Possible causes which have been suggested include Rhizomania, selections of sugarbeet varieties which are not suited to the area in production, or soil-borne fungal, bacterial, and other viral pathogens. Our results suggest that Rhizomania is not the cause, and that other soil-borne sugar beet viruses may have an important role. Our preliminary results indicate that the soil-borne viruses of beet, in particular *Beet soil-borne mosaic virus* (BSBMV) and possibly *Beet soil-borne virus* (BSBV), are important factors in limiting beet production.

The objectives of this study during 1999 were to continue to study the effect of soil-borne viruses that may be associated with the decline. In addition, we conducted a small scale, preliminary field trial to evaluate the effect of fumigation on beet growth, sugar production and the presence of soil-borne viruses.

Materials and Methods:

A. Fumigation Trial: Four varieties were selected for the fumigation trial in Scottsbluff, NE. These were: Monohikari, Beta 4038r, Beta 1399, and Beta 9155. Each variety was replicated six times in both a fumigated section and a non-fumigated section. Four beets were individually dug by hand and topped at the lowest leaf scar at two dates in the growing season; 6-28-99 and 7-9-99. Roots were washed free of soil and scraped for root hairs and epidermal tissue. Samples were transported to Salinas for testing by ELISA for BNYVV and BSBMV, and for mechanical inoculation to indicator plant for miscellaneous viruses. Results from this study are presented in Table 1.

B. Mixed infections: See BSDF 281 report, Table 2.

C. Resistance to BSBMV: See BSDF 281 report, Fig 1.

Results:

Although the fumigation study was not set up in a randomized complete block design due to constraints placed on us which precluded our obtaining statistically significant data, we do see a trend in the fact that fumigation had a positive effect on production as seen by the levels of % sucrose and tons per acre (Table 1). However, it is not clear what is being controlled. There was a very low level of BNYVV and BSBMV as seen in individual plant tests, but this does not show up in our overall averages for these viruses as measured by ELISA. Other than BNYVV and BSBMV, no other virus was detected in this field trial. Further studies are needed in fields known to have a history of infestation by BSBMV in a fumigation trial to measure the true effects of this virus on beet production.

Conclusions:

In several states in the United States both BNYVV and BSBMV have been found. BSBMV has been shown in greenhouse trials to have a significant effect on growth of beets. Resistance to BSBMV has not yet been identified, and the effects of these two distinct viruses appears to be more significant than either one alone, depending on the variety planted. In addition, resistance to Rhizomania does not confer resistance to BSBMV, and efforts should be made to find resistance to this virus. Fumigation in last year's study appeared to show a trend of having a positive effect on beet growth and % sugar. However, this was not an optimum test, for the reason that the field was not heavily infested with BSBMV, and it was not set up in a randomized complete block design. Now that we have identified infested fields, and the crop rotation is back to bees in some fields, we plan to replicate another fumigation test in an infested field. This will depend on the availability of appropriate fields and the cooperation of growers.

Table 1. Comparisons Between Fumigated and Non-fumigated Soil on Sugarbeet Production. Scottsbluff NE, 1999.

Variety	% Sucrose	Ton/A	Lb sugar/A	BNYVV (OD/H)	BSBMV (OD/H)
Fumigated					
Monohikari	14.10	29.66	8368	1.22	1.33
Beta 4038R	12.83	30.86	7916	1.56	0.80
Beta 1399	14.16	25.05	7105	1.23	0.74
Beta 9155	13.61	31.96	8696	1.41	1.03
Mean	13.68	29.38	8021.3	1.36	0.98
LSD (.05)	0.68	4.25	1458.9	0.59	0.52
Non-Fumigated					
Monohikari	14.00	24.60	6905	1.28	1.10
Beta 4038R	13.32	26.60	7082	1.19	0.86
Beta 1399	14.75	22.50	6655	1.42	1.00
Beta 9155	13.80	29.56	8151	1.33	1.19
Mean	13.97	25.82	7198.2	1.31	1.04
LSD (.05)	0.53	2.46	739.3	0.34	0.66

Part II: Continued study of the new luteovirus causing yellowing in the United States

B. Etiology and transmission properties of BChV (collaborators H.-Y. Liu, W. M. Wintermantel, R. T. Lewellen): Since 1995, a yellowing disease of sugarbeet has been frequently observed in Colorado, Nebraska, and California sugarbeet fields. Symptoms of this disease are identical to those caused by beet western yellows virus (BWYV) including interveinal yellowing and necrotic lesions caused by *Alternaria sp.* BWYV isolates from beet have a wide host range and are readily distinguished by systemic infection of shepherd's purse (*Capsella bursa-pastorus*) and lack of infection of *Chenopodium capitatum.* These newly described isolates have a narrow host range and show interveinal reddening on *C. capitatum* but do not infect shepherd's purse. Biological properties indicate these isolates are distinct from BWYV. This disease is readily transmitted (only one aphid is needed to transmit at an efficiency of 36.6%) (Table 1) in a persistent manner by the green peach aphid (*Myzus persicae*), but is not mechanically transmissible. The virus has been

purified and the virus particles are isometric and 26 nm in diameter. The coat protein from purified preparations is ca. 23 kDa. This disease may be more damaging to sugarbeet but because of the narrow host range may be more readily controlled by host-free periods than conventional BWYV strains. (This abstract was presented at the 1998 APS meeting, November, 1998.)

Materials and Methods: This year specific antiserum has been developed in our lab which recognizes BChV only. Previously, all antisera to BWYV reacted to both BWYV and BChV, thus hampering a diagnostic test based on serology. Results from our ELISA tests are shown in Table 1.

Serological Reactions to "Yellows Antisera

	antisera	
Antigen	BChV	BWYV
BChV	+	+
BWYV	-	+
Healthy	-	-

Conclusions:

Progress has been made in determining the etiology of BChV its relationship with other yellowing luteoviruses infecting sugarbeet, and sources of resistance to BChV. BChV is now considered to be a new and distinct member of the luteovirus group of aphid transmitted viruses, and a distinct member of the virus yellows complex. Aphid transmission is highly efficient, with only one aphid necessary to transmit BChV. Sources of infection still need to be determined, and specific diagnostic probes to be made available. An ELISA test will be refined this year which is specific only to BChV. Molecular probes will also be made available which recognize each member of the yellows complex individually. Progress is being made in our lab to determine the interactions between the members of the virus yellows complex.

The old and the new: viruses of sugar beet and their impact on beet production in California.

The California Sugar Beet 1999 Annual Report:27-30.

G.C. Wisler

The diverse climate of California lends itself well to a diverse agricultural industry. The variety of weeds, crops, insect and fungal vectors also provide favorable conditions for plant virus disease development. Viruses have had a significant impact on production since sugar beet was first introduced to California, and continue to do so today. ***Beet curly top curtovirus*** (BCTV; family *Geminiviridae*) almost destroyed a fledgling sugar beet industry soon after its establishment in the 1870's. A combination of resistant varieties, cultural and chemical management of beet crops to provide early plant emergence and development, and a highly coordinated beet leafhopper scouting and spray program have allowed for adequate control of BCTV. These programs were initiated by the USDA-ARS in Salinas, California and the University of California, and are still in place today. Populations of the vector of BCTV, the beet leafhopper (*Circulifer tennellus*) are monitored and can still achieve proportions which can be extremely damaging to the beet crop. Breeding programs continue to evaluate resistance to curly top, as this virus still poses a real threat to production. For example, in 1992 Idaho had the most severe outbreak of curly top in over 20 years, which caused an estimated loss to the sugar beet industry of $15 million. That was the same year that Rhizomania was first identified in Idaho, thus curly top received relatively little attention. The sugar beet industry should continue to maintain the current scouting program, and breeding programs must continue to improve the resistance that is available for curly top.

"Virus yellows" describes a complex of yellows-inducing viruses that are aphid-transmitted. In the past, this complex has consisted of ***Beet yellows virus*** (family *Closteroviridae*) and ***Beet western yellows virus*** (family *Luteoviridae*). ***Beet mosaic virus*** (BtMV) is often part of this complex, but its importance to the yellowing disease is not completely known. In Europe, ***Beet mild yellows virus*** (BMYV; family *Luteoviridae*) is part of the virus yellows complex. Early descriptions suggest that virus yellows occurred in the Salinas Valley as early as 1921 when it came to be known as "June Yellows" because by mid-summer. Factors influencing the epidemiology of virus yellows include vector populations, virus/vector relationships and virus sources. From 1950 until the late 1960's, beet yields continuously declined because of increased incidence of the virus yellows complex.

BYV is transmitted in a semi-persistent manner and is retained by the vector for less than 72 hr. This type of transmission suggests that the spread of the virus from the source is local, i.e. the disease incidence is high in areas adjacent to the virus source but quickly decreases with distance. The primary source of BYV is beet itself, including overwintering beets and volunteers in abandoned fields or waste sites. BWYV is transmitted in a persistent manner by aphids, meaning that it circulates through the insect and is maintained for the life of the insect. Thus, distribution of BWYV is more general and widespread than BYV. BWYV infects numerous weeds and other crops, including lettuce. A new component of the yellows complex was identified in the past few years, through the collaborations between the USDA-ARS in Ft. Collins, Colorado and Salinas, and the University of Nebraska. This virus has been identified in Colorado, California, Texas, and in Oregon. It has been named ***Beet chlorosis virus*** (BChV), a

distinct member of the Family *Luteoviridae*. Symptoms closely resemble BWYV when it is found as a single infection in sugar beet, with intense interveinal yellowing accompanied by *Alternaria* lesions. Symptoms are more orange than yellow in color as with BWYV, and leaves are characteristically thick and brittle. However, these differences are subtle, and BChV and BWYV cannot be differentiated by symptoms alone. Diagnostic tests can include specific nucleic acid tests, serology, and transmission to specific indicator plants by the aphid vectors. The most diagnostic host range difference between these two viruses is that BChV infects *Chenopodium capitatum* but not shepherd's purse (*Capsella bursa-pastorus*), whereas BWYV infects shepherd's purse and not *C. capitatum*. BWYV has a wide host range, whereas BChV has a limited host range. Alternate, or overwintering weed hosts for BChV have still not been identified in areas where BChV has been found. In two years of extensive sampling surrounding weed hosts in Colorado, Nebraska, and California, none was found to be infected with BChV. Thus, the epidemiology of this new virus is not completely known.

Epidemiological studies in the late 1950's by J. E. Duffus established a close correlation between virus yellows incidence and proximity of overwintered beet fields. Sugar beet growers and processors reached agreements to maintain beet-free periods between harvesting and sowing new crops throughout California. This included the destruction of volunteers or "groundkeepers" and weed beets. Because of the diverse planting dates throughout the state due to the diverse climates, beet-free periods differ between beet growing districts. These programs were first introduced in the 1968 crop. Following the introduction of the beet-free period in 1968, the average sugar production in California increased yields by about 40% in the subsequent growing seasons.

Virus yellows re-emerged in 1985 in Northern California as a result of increased aphid populations and erosion of beet-free periods. *Myzus persicae* has been the most common aphid vector of the yellows virus complex. In recent years, however, populations of the black bean aphid, *Aphis fabae*, have increased. Although it is a less efficient vector than the green peach aphid, the black bean aphid has complicated the beet-free periods as a means of disease management because it is more heat tolerant than the green peach aphid and has longer flight periods. This situation extends the period for aphid transmission. Thus, beet-free periods are more important than ever before, and the beet industry has enforced them within beet production districts.

Variety trials conducted in 1997 by R. T. Lewellen of the USDA-ARS, Salinas, showed that the yield reduction caused by BChV was similar but more severe than that caused by BWYV. Sugar yield losses ranged from about 5 to 40%, depending on the variety. The loss pattern for BChV fits the pattern for that of BWYV and BMYV. Lines and hybrids from the virus yellows resistance breeding program at Salinas tended to be the most resistant. The most susceptible commercial hybrids tested were those that have been grown in Colorado and Nebraska where BChV has caused significant damage in the past several years. Future breeding programs in Salinas will continue to evaluate resistance to BChV as a virus yellows complex with BWYV and BYV.

The development of ***Lettuce infectious yellows virus*** (LIYV) in the southern United States to epidemic proportions, and its apparent disappearance in current cropping systems is an excellent example of the impact that insect populations, cropping patterns and transmission characteristics have on virus ecology and epidemiology. Although LIYV was first described in lettuce, it caused significant losses of sugar beet, cucurbits, and other crops in the southwestern United States for a period of time between 1980 and the early 1990's. LIYV is the type member of the genus *Crinivirus* (family *Closteroviridae*) and is transmitted primarily by the sweetpotato whitefly, *Bemisia tabaci* biotype A. It induces yellowing and necrosis on infected plants

accompanied by a significant reduction in yield. In 1981, lettuce, cucurbits, and sugar beet crops were ubiquitously infected with LIYV, resulting in losses exceeding $20 million in one growing season. Lettuce yielded 50 to 75% lower than in previous years and sugar beets yielded 20 to 30% less than expected.

Bemisia populations changed during the 1980's and early 90's in the sunbelt states of the U. S., and throughout the tropical and subtropical zones worldwide due to the displacement of biotype A by biotype B. Whereas LIYV is transmitted efficiently by biotype A, it is transmitted 100-fold less efficiently by biotype B. The populations of biotype B increased to astronomical proportions by 1990. The fall melon crops which provided a bridge between consecutive beet and lettuce crops were eliminated due to feeding damage by the B biotype. As a result, LIYV has been virtually eliminated and is no longer found in the southwestern desert.

A second, potentially destructive whitefly-transmitted virus, termed ***Lettuce chlorosis virus*** (LCV), was found in the Imperial Valley of California after LIYV was no longer present. LCV has several characteristics in common with LIYV, including the typical symptomatology of interveinal yellowing of lower leaves, stiffness of leaves, and leaf necrosis. In contrast to LIYV, both the A and B biotypes of *B. tabaci* are efficient vectors. LCV is similar to LIYV with respect to its host range, except that LCV does not infect members of the *Cucurbitaceae*. The whitefly population is currently being controlled in lettuce by use of the insecticide imidacloprid, and thus LCV has not been an economically significant problem, although it is consistently identified in symptomatic lettuce and sugar beet when yellowing symptoms are found in the southwestern United States. The Imperial Valley sugar beet industry has experienced world record yields in the past few years. Thus, the concern for LCV is low at this time. As resistance to insecticides builds up in the whitefly population, or cropping patterns change, LCV could become a potential epidemiological problem. The industry should continue to monitor for yellowed fields.

Resistance or tolerance to LIYV was developed in lettuce, sugar beet, and cucurbit varieties as a result of the epidemics. Preliminary studies are underway to determine if the resistance to LIYV in lettuce and sugar beet confers resistance to LCV as well. There has been some speculation that perhaps LCV may have been present during the LIYV epidemics and the resistance may be useful for more than one crinivirus infecting these crops. For example, the USDA-ARS sugar beet breeding program for the "virus yellows" complex of luteoviruses and closteroviruses was ongoing in the Imperial Valley when LIYV was prevalent. Because selection was based on absence of yellowing, varieties resistant to LIYV were developed before the causal agent was even characterized.

Rhizomania, caused by ***Beet necrotic yellow vein virus*** (BNYVV), was first identified in the western hemisphere in 1984 in Paso Robles, California. It has since been identified in Texas, Colorado, Nebraska, Idaho, Minnesota and Oregon. To date, it has not been found in Washington, Michigan, or Ohio. The beet industry is well aware of the symptoms and effect of rhizomania on beet production, and precautions that should be made to prevent its spread. This disease is soil-borne, and is transmitted by the plasmodiophorid fungus, *Polymyxa betae*. The primary source of spread is through the movement of infested soil or beets. Great strides have been made with regard to resistance to rhizomania, and growers are urged to plant these varieties whenever possible in soils known to be infested. In addition, cultural control methods can be employed to manage this disease. These include planting early into cool soils, minimizing overwatering, and crop rotations to reduce levels of virus in the soil. Resistant varieties that are available now yield as well as nonresistant beets under non-rhizomania conditions. Recent studies clearly show that the dose of the *Rz* allele for resistance to rhizomania is directly

correlated with virus levels, rhizomania disease index scores and root weight. With regard to virus levels in infected sugar beets, *Rzrz<Rzrzrz<rzrz≈rzrzrz* .

There are other soil-borne viruses that infect sugar beet in addition to BNYVV. These have been found throughout the United States where beets are grown, with the exception of California. These viruses have not been as thoroughly studied as BNYVV has, thus less is known about the epidemiology of these viruses. In our lab, we have still not detected these "other" viruses from beets grown in California. However, they appear to be fairly widespread in other beet-growing states. ***Beet soil-borne mosaic virus*** (BSBMV) is one in particular that has been fairly well characterized. Although every isolate of BSBMV that has been found reacts the same in serological tests, on a molecular level they appear to be a closely related family of viruses, which vary according to their particular ecological niche. This indicates that these virus isolates may actually be endemic to the United States, and have changed and evolved here. BSBMV has not been positively identified in Europe or the United Kingdom. ***Beet soil borne virus*** (BSBV) is another soil-borne beet virus which is being found more frequently. In preliminary studies of beets in Nebraska and Colorado, where a significant decline in yield has occurred over the past several years, 24 of 27 affected fields were infested with either BSBMV, BSBV, or both. Only one field was infested with rhizomania. Although these data do not provide conclusive evidence that these viruses are the cause of the declines experienced by growers, the information needs to be investigated further. Years of research has shown that BNYVV causes rhizomania. Other than a low incidence of leaf symptoms for BSBMV that resemble BNYVV leaf symptoms, the virus symptoms for these other soil-borne viruses are not well-known. It is likely, however, that BSBMV and BSBV cause a reduction in yield. How extensive that reduction can be is unknown at this time, and studies are underway to attempt to document that reduction under controlled field conditions. The possible interaction that can occur between BNYVV, BSBMV, and BSBV is another area of concern for researchers and the industry alike. Preliminary studies indicate that two viruses as mixed infections are more severe that either virus alone. Although BSBMV may not exist yet in California, based on our experience with the movement and spread of rhizomania, it is likely that it will be introduced in the future. Pathologists and sugar beet geneticists are preparing themselves for that eventuality by learning more about these viruses and their interactions, and investigating the possibility of resistance to these soil-borne viruses.

Project 220

Viral transgene-mediated resistance to *Beet yellows virus* as a model for engineered virus resistance in sugarbeet

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Introduction: Virus yellows consists of a complex of viruses causing beet leaves to turn yellow prematurely, and has contributed to disease-related losses in California sugarbeet production for many years. This disease complex is composed of members of two main genera of plant viruses, a *Closterovirus* and a *Luteovirus*. Occasionally a *Potyvirus* is also present. Once plants begin showing initial yellowing symptoms, losses accumulate approximately 2 percent each week through the remainder of the growing season. Direct annual losses to virus yellows average in excess of $36 million, without considering indirect effects such as the displacement of production areas, increased freight costs, and potential loss of processing facilities due to disease-related yield and revenue reductions.

Plant virus resistance obtained through transformation with foreign genes (transgene-mediated resistance) can increase the level of resistance in cultivars which partially control a particular disease, and can provide resistance when none is available through traditional breeding. This project examines the potential for transgene-mediated resistance against *Beet yellows virus* (BYV) in sugarbeet. BYV is a major component of the virus yellows complex, and has been identified by the California sugarbeet industry as a primary concern. Engineered BYV resistance should complement current resistance/tolerance to *Beet western yellows luteovirus* (BWYV), the other major viral partner in the virus yellows complex. Transgene-mediated resistance has been studied extensively for a number of years. Since its development in the mid 1980s, transgene-mediated resistance has been developed for control of a large number of plant viruses in many different hosts (Baulcombe, 1996; Deom, 1999), including limited attempts to control BNYVV in sugarbeet (Kallerhoff et al., 1990; Ehlers et al., 1991). There are several means by which foreign genes can engender resistance, and often more than one approach can achieve resistance against a particular virus. For example, transgenic resistance has been achieved for tobacco mosaic virus using viral replicase transgenes as well as by using viral coat protein transgenes. The means by which the replicase transgene produces resistance differs from the mechanism by which coat protein-mediated resistance operates, at least for tobacco mosaic virus. The choice of a transgene (the foreign gene being inserted into the sugarbeet genome) must be determined through careful analysis of the interaction between the targeted virus and the sugarbeet plant. The transgene must be able to block the virus infection cycle such that the virus cannot bypass the mechanism of the resistance. It is important, therefore, to have a solid understanding of the nature of the infection process and how disease develops for each virus targeted for transgene-mediated resistance. BYV is transmitted by aphids in a semipersistent manner (requiring long feeding times for acquisition and transmission by vectors). In infected plants, BYV is usually restricted to phloem tissues (sieve tubes, companion cells and phloem parenchyma), but is occasionally found in the mesophyll and epidermis near local lesions.

This suggests that strategies which interfere with virus replication and packaging should be effective in generating resistance to BYV.

Purpose: The BYV resistance project is part of a long-term effort to engineer sugarbeets for resistance against plant viruses through transformation with foreign genes, and focuses on development of virus resistance to BYV as a model for using biotechnology to control virus diseases in sugarbeet. The main objectives are as follows:

1. Development of nucleic acid constructs for use in plant transformation
2. Identification of genes which confer resistance against BYV
3. Optimization of sugarbeet transformation and regeneration procedures for select sugarbeet germplasm

Accomplishments: A plant transformation facility was completed in March, 1999, and during the past year we have concentrated on the transformation and regeneration of sugarbeet through tissue culture, as well as development of constructs for sugarbeet transformation with a goal of resistance to beet yellows virus (BYV). Efforts are in progress to improve regeneration efficiency, as this a crucial, limiting step in the sugarbeet transformation procedure. Experiments involving sugarbeet were initiated in the fall of 1999. Constructs for use in plant transformation have been developed, and additional constructs are in progress.

Approach: Cloned BYV genes were generously provided by V. Dolja (Oregon State University, Corvallis, OR). BYV genes have been isolated, modified, and inserted into binary plant transformation vectors. A binary vector, provided by W.R. Belknap (USDA-ARS, Albany, CA) is being used for most transformations to reduce end-product licensing requirements. Plant transformations are being performed using *Agrobacterium tumefaciens*. Initial transformations are being performed on both sugarbeet and *N. benthamiana*, an alternate host for BYV. *N. benthamiana* can be transformed easily using standard procedures (Rogers et al., 1986), and transgenic plants can be tested for resistance to BYV in a fraction of the time required to obtain transgenic sugarbeet. As constructs are identified which provide effective resistance against BYV in *N. benthamiana*, these will be used for transformation of sugarbeet. Procedures for sugarbeet transformation and regeneration include portions of methods used by Doley and Saunders (1989), D'Halluin et al. (1992), Krens et al., (1996) and others, with some modifications. Transgenic plants will be tested for the presence of the transgene by PCR analysis. Plants exhibiting strong resistance will be subjected to Southern blot analysis to determine the number of copies of the transgene in these plants. A number of different sugarbeet tissues are being used for transformation, including young (not fully expanded) leaf tissue, petiole and bolt tissue. Beet varieties to be used for transformation have been provided by R.T. Lewellen. After resistant, stable transformants are identified, plants will be turned over to R.T. Lewellen for seed production and introduction into the breeding program.

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Project 221

Examination of viral interactions in relation to disease severity and resistance in the virus yellows complex of sugarbeet.

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Introduction: Virus yellows has contributed to disease-related losses in California sugarbeet production for many years. Once plants begin showing symptoms, losses increase approximately 2 percent each week through the remainder of the growing season. This disease complex is composed of members of two main genera of plant viruses, a Closterovirus and a Luteovirus. Occasionally a *Potyvirus* is also present. In California, BYV is the predominant Closterovirus involved, and BWYV and *Beet chlorosis virus* (BChV) are the principal Luteoviruses in the complex. The Potyvirus, when present, is almost exclusively BtMV. BtMV is generally not considered an economically significant pathogen alone, however BYV, and the Luteoviruses can effect yields substantially in single infections. All of these viruses are transmitted by aphids, particularly the green peach aphid and the black bean aphid. Although beet-free periods are useful in managing virus yellows, the increased range and population of the black bean aphid has made this disease more difficult to control in recent years. Once plants begin showing symptoms, losses increase approximately 2 percent each week through the remainder of the growing season. Traditionally, breeding for resistance has involved breeding for control of the yellowing symptom. BtMV causes symptoms on young plants, but as symptoms of the yellowing viruses develop, mosaic symptoms decrease. Currently, beet varieties are available which exhibit some tolerance to BYV, and field resistance to the *Luteoviruses*. Most commercial varieties do not exhibit substantial levels of resistance to BtMV.

The relationship in sugarbeet between the three viruses in disease induction is not clear. Although all 3 viruses are present in plants at the same time, it was not clear at the beginning of this project whether the yellowing and stunting symptoms associated with the disease are more severe when multiple viruses are present or not. Furthermore, it was not known whether the presence of one virus facilitates or hinders the activity of another. Possible interactions were suggested by observations that yellowing disease and sugar yield reductions were more severe when both BYV and BWYV were present (R. Lewellen, personal communication). It is also noteworthy that BtMV is not considered a serious problem in beet, even though it is often present with BYV and/or BWYV. This study addresses whether synergism or suppression occurs in the virus yellows complex on sugarbeet, and will increase our understanding of the relationship between the virus components of the yellows complex. This knowledge may be helpful in identifying sources of resistance to the yellows complex, and in the development of new resistant varieties.

Approach: Sugarbeet breeding lines have been selected that are either susceptible to, or exhibit a range of resistance levels to each of the three target viruses. These lines are being challenged by aphid-inoculation of BYV, BWYV, and/or BtMV. Plants are inoculated with each virus individually, with all combinations of two viruses, and finally, all 3 viruses are inoculated together. Mock inoculations are also performed with virus-free aphids. Symptom development

is monitored over the course of each experiment, and total nucleic acid samples are prepared from symptomatic leaves. Total nucleic acid concentrations are equilibrated, and replicate dot blots (a form of nucleic acid hybridization) are performed to compare relative levels of each virus in single, double, and triple infections. Relative amounts of viral RNA are compared by phosphorimage analysis of dot blots. At the conclusion of each experiment, soil is removed from roots, and top and root are separated to determine the effects of each virus combination on root and top weight, compared with healthy controls.

Preliminary Results: Sugarbeet containing mixed infections of more than one yellowing virus exhibit greatly increased stunting and reduced root weight compared with single infections and mock-inoculated plants. This pattern is particularly evident in susceptible beet varieties, but also occurs to a lesser degree in varieties exhibiting resistance to BWYV and tolerance to BYV. Effects on beet leaves are not as apparent, particularly when BYV is present. BYV causes a thickening of leaves, resulting in heavier weight.

Experiments in progress are comparing virus titer in sugarbeet infected with each virus individually, mock-inoculated plants, as well as all possible combinations of mixed infections to determine if any synergism or suppression occurs in sugarbeet infected with more than one yellowing virus. Current results suggest substantial synergism between BYV and BtMV, resulting in greatly reduced root weights, but only mild synergism between BYV and BWYV. This data will be correlated with effect of mixed infections stunting severity, root and leaf weight, as well as virus concentration in single and mixed infections.

DEVELOPMENT OF SUGARBEET BREEDING LINES AND GERMPLASM

R.T. LEWELLEN

C26, C27 & C51 - *Beta vulgaris* L. germplasm lines C26 (PI610488), C27 (PI610489), and C51 (PK593694) were developed by the USDA-ARS in cooperation with the Beet Sugar Development Foundation and the California Beet Growers Association. C26 and C27 were released in 1999. C51 was released in 1996. The germplasm base of sugarbeet (*B.vulgaris*) is believed to be relatively narrow compared to its ancestral source *B.vulgaris* L. subsp. *maritima* (L.) Arcang. *Beta vulgaris* subsp. *maritima* (*Bvm*) occurs from the Mediterranean Basin through the Near East and north along the Atlantic shore to Denmark. The major geographic ecotypes of *Bvm* are the easy bolting annuals of the Mediterranean Basin and the harder bolting annuals or biennials of western Europe. Both of these ecotypes are difficult to evaluate directly for reaction to diseases and pests and for agronomic traits. Even though fully cross compatible with sugarbeet, synchronizing flowering of *Bvm* with biennial sugarbeet is often difficult. To overcome these problems and to make the broadly based germplasm of *Bvm* more accessible for evaluation and breeding, groups of *Bvm* accessions were crossed to sugarbeet and improved. The broadly based germplasms C26, C27, and C51 are populations from these prebreeding programs at Salinas.

C26 is a multigerm, self-fertile line that theoretically received 50% of its germplasm from sugarbeet and 50% from *B. vulgaris* subsp. *maritima* (*Bvm*). The wild sea beet *Bvm* principally was derived from accessions collected by Doney et al. in France, UK, and Ireland. C26 was developed from crosses between sugarbeet line C37 and *Bvm*. The sources of the *Bvm* plants were from accessions tested in the 1991 and 1993 Sugarbeet Crop Germplasm Committee (CGC) sponsored tests at Salinas. Plants from within individual PI accessions that showed high resistance to rhizomania caused by beet necrotic yellow vein virus were selected. In 1991, about 200 selected plants from 20 accessions collected in the UK and 6 accessions collected in Ireland were bulked and increased in mass in 1992 to produce a *Bvm* population called R423 (PI599350). In 1993, about 160 rhizomania resistant plants from 11 PI lines collected in France were bulked. Stecklings from population R423 and the bulked selected plants from the French accessions were combined into a single pollinator in 1994 and crossed in bulk to C37. Seed from the *Bvm* plants were called R423B (PI599351). C37 is uniformly susceptible to rhizomania and has only green hypocotyls. Seed harvested from the C37 seed-bearing plants was sown in August 1994 into a field plot with rhizomania infestation. In December 1994, F_1 plants were selected and increased in 1995 by open pollination to produce an F_2 population called R526. Records were not maintained as to the contribution of each wild beet accession or which accessions were specifically involved. The UK accessions were in the PI518298-518372 (WB620-694) series. The Irish accessions were in the PI518381-518416 (WB703-738) series. The French accessions were in the PI540598-540608 (WB852-862) series.

Plants from the F_2R526 population were grown in the field under rhizomania infested conditions and were inoculated with beet yellows and beet western yellows viruses, the cause of virus yellows (VY) *Erwinia carotovora* (Jones) Bergey et al. subsp. *betavasculorum* Thomson et

al. and *Erysiphe polygoni* DC, the cause of powdery mildew. Individual plants were selected for resistance to rhizomania, Erwinia root rot, powdery mildew, and for nonbolting, beet conformation, root size, and sucrose concentration. Selection for VY was indirect and was based upon individual root performance for root and sugar yield. Selected roots were increased in mass by open pollination to produce F_3 line R726. From R726, two successive selections were made under field conditions for resistance to rhizomania, nonbolting, and root conformation and size and increased to produce the F_5 line R926 that was released as C26.

C26 should have performance and traits similar to its F_3 and F_4 generations. The F_3 line R726 and F_4 line R826 have been evaluated in field trials at Salinas and Brawley, CA. They have shown high resistance to rhizomania. Most plants appear to be biennial or hard bolting annuals. Pigmentation is mostly similar to that of sugarbeet but some *Bvm* patterns still occur. Under rhizomania and/or VY conditions, the components of yield except for lower juice purity are similar to other open-pollinated lines of sugarbeet. Under VY infected conditions, R726 has yellowing symptoms that score similar to the most tolerant sugarbeet lines. Under mild cercospora leaf spot epiphytotic at Salinas, R726 was moderately resistant but in subsequent tests in CO and MN, it was moderately susceptible. C26 has a dark green canopy, similar to the coloration of many *Bvm* lines from NW Europe but without the thickened leaves. C26 is an enhanced, broadly based population from which useful genetic variability might be found for the future improvement of sugarbeet.

C27 is a multigerm, self-sterile line with sugarbeet and *B.vulgaris* subsp. *maritima* (*Bvm*) germplasm. The sea beet *Bvm* component was selected from accessions being evaluated for resistance to rhizomania in the 1996 Sugarbeet CGC sponsored test at Salinas. About 200 *Bvm* rhizomania resistant plants from 19 accessions were selected. These accessions represented introductions from UK (PI518426, PI518435, and PI518440), Poland (PI535833, PI535835, and PI535843), and France (PI540568, PI540575, PI540588, PI540593, PI540596, PI540598, PI650599, PI540600, PI540601, PI540602, PI540603, PI540604, and PI540605). After vernalization, the selected *Bvm* plants were bulked and transplanted into a seed isolation plot with sugarbeet lines C37 and C69. All plants in the seed plot could have crossed inter se. Seed from the *Bvm* plants was called R720 (PI599352). Seed harvested from C37 was called R727A and that from C69 was called R727B. These seed lots would have contained sibmated, interline crosses, and F_1 individuals. Resistance to rhizomania and wild beet plant type and color patterns were used to identify sugarbeet x *Bvm* F_1 plants. Selected F_1 plants from both sugarbeet parents were bulked and increased to produce a single F_2 population called R827. From R827, beets were selected for resistance to rhizomania, nonbolting, root size, and beet conformation and increased to produce the F_3 population R927 that was released as C27.

C27 segregates for high resistance to rhizomania. Resistance could have been derived from C69 (factor *Rz*) and/or *Bvm*. The allelism or uniqueness of the resistance from *Bvm* to *Rz* and other previously identified sources of resistance is not known. C27 has had limited agronomic evaluations but should be broadly based, enhanced germplasm from which new genetic variability can be identified for the future improvement of sugarbeet.

C51 is a self-sterile, multigerm, germplasm line that theoretically received 50% of its germplasm from sugarbeet and 50% from *B.vulgaris* subsp. *maritima* (*Bvm*). The *Bvm* germplasm was derived from a collection of about 60 accessions collected primarily from the Mediterranean Basin. C51 is an advanced version of C50 (PI564243 and PI59079) that has been improved for sugarbeet traits and disease resistance. From C50 [= F_3 (sugarbeet line C54 x *B.vulgaris* subsp. *maritima*)], improved subpopulations were created by four to six cycles of

recurrent phenotypic selection for various combinations of productivity and host-plant resistance. Selections were made for biennialism, root and crown conformation, sucrose concentration, and root yield. Concurrently, selections were made for resistance to rhizomania, and/or VY. In 1995, mother roots selected for sucrose concentration and yield under severe rhizomania conditions from eight or these subpopulations were recombined to for C51. The component lines of C51 have been tested as versions of breeding line R22, e.g., R422Y3 and R422R5. C51 was released and evaluated as breeding line R522.

Subpopulation components of C51 (R22R lines) that had been selected for resistance to rhizomania have performed very well under severe rhizomania conditions. In tests at Salinas and Brawley, CA, they often have had comparable sugar yield to commercially available rhizomania resistant hybrids. At Brawley under rhizomania conditions, these lines have shown the best known resistance to high temperature root rots and plant death. There is evidence that a factor or factors in C51 conditions a higher level of resistance to rhizomania (BNYVV) than that conditioned by *Rz*, the Holly gene. Experimental hybrids show that this factor in C51 is expressed in a dominant manner.

Subpopulations of C51 (R22Y lines) that had been selected for VY resistance on the basis of sugar concentration and yield have performed relatively well under both VY infected and noninfected conditions as compared to normal VY tolerant sugarbeet lines. Under nondiseased conditions, these R22Y lines have shown surprisingly high sucrose levels. These results suggest that C51 might be a source for new genetic variability for sugar concentration and yield as well as disease resistance.

C51 likely will be most useful in the near term as a source for high levels of resistance to rhizomania and for plant persistence under the combined effect of rhizomania and high temperature conditions. Resistance to rhizomania from C51 has been backcrossed into C37 and released as C79-8 and into other sugarbeet backgrounds and released as C67 (PI599340) C72 (PI599342) and C890-8. In a longer term, C51 should provide useful genetic variability for resistance or tolerance to virus yellows, other sugarbeet diseases and pests and possible for components of sugar yield productivity.

DOWNY MILDEW - Downy mildew caused by *Peronospora farinosa* had a high incidence in the November planted bolting evaluation trials (Tests 199-999). Prior to attempted control with Ridomil-Gold MZ, counts of visibly infected plants were made on May 26, 1999. In the late 1940s and 1950s, resistance to downy mildew (DM) was one of the main breeding objectives at Salinas. DM can be severe in winter planted beets in the coastal states including the seed fields of Oregon. Since about 1965, selection for resistance to DM has been a minor part of the breeding program. It appears that in this time, there has been a shift from a moderately resistant germplasm base to a more susceptible base. However, the older lines known to have been resistant in the 1960s still appear to be moderately resistant, e.g., C562. Considerable variability among and within breeding lines for reaction to DM is evident in these 1999 tests. For example, C76-89-5 appears to be one of the more resistant breeding lines (Test 299, 199, 499). In Test 499, full-sib lines generated from C76-89-5 to evaluate for nonbolting, components of yield, and resistance to diseases (e.g. virus yellows, rhizomania, Erwinia, powdery mildew) were evaluated for reaction to DM. Individual FS's from C76-89-5 ranged from 0 to 26% infected plants whereas, FS's from other lines showed up to 92% infection. In test 699, S_1's from the F_1 hybrid of C76-89-5 x popn-931 ranged from 0 to 100% infected. S_1lines

from popn-931 (Test 799) ranged from 2 to 86% infected. These counts suggest a significant genetic component for reaction to DM. At some point in the future, it may be of interest to do a genetic analysis of this resistance. To my knowledge the inheritance of downy mildew resistance in sugarbeet has never been elucidated.

INDEX OF VARIETY TRIALS, SALINAS, CA, 1999
U.S. AGRICULTURAL RESEARCH STATION

Tests were located in three field plot areas at Salinas and two at Brawley, CA. Disease nurseries were also used in Idaho, Colorado, and Minnesota. Tests at Brawley (Imperial Valley) were planted in September and October 1998, and harvested from May through July, 1999. Tests at Salinas were planted from November, 1998, through August, 1999, and harvested from September through December. Tests at Spence Field (Salinas) were under both rhizomania and nonrhizomania (following methyl bromide fumigation) conditions. Herbicides were not used in Block 6 trials that followed strawberries and methyl bromide fumigation. Nortron, Pyramin, Betamix, Progress, and Poast were used in the other trials. Bayleton at 2lbs material/acre was used for powdery mildew control. Lorsban-4E was applied for aphid and other insect control. The specific planting and harvest dates as well as plot size and design are shown on each test summary.

Tests are listed in the main Table of Contents for Salinas by types of material and evaluation. As an aid to find test summaries, they are listed below by ascending test (planting date) number and cross- referenced to the page number. Tests shown as N/A are not available or included in this report.

TEST NO.	NO. ENTRIES	TEST DESCRIPTION	PAGE NO.

VIRUS YELLOWS (BYV-BWYV-BChV) PROGENY TESTS, BLOCK 3, PLANTED APRIL 1999

1199	32	VY evaluation of selected MM S_1 progeny lines	n/a
1299	64	VY evaluation of lines (BTS)	n/a
1399	48	Full-sib progeny from lines with *Bvm* gp	n/a
1499	112	Full-sib progeny from C31*Rz*-type lines	n/a
1599	64	Full-sib progeny from C78 & C80	n/a
1699	80	S_1 progeny from F_1 (MM.S^f.Aa.*Rz*) lines	n/a
1799	32	S_1 progeny from MM.S^f.Aa.*Rz* populations	n/a
1899	48	S_1 progeny from mm.S^f.Aa.*Rz* populations	n/a

VIRUS YELLOWS (BYV-BWYV-BChV) EVAL., BLOCK 5, PLANTED MARCH 1999

2099	24	VY evaluation of topcross hybrids	A 52
2199	48	VY evaluation of breeding lines	A 36
2299	48	VY evaluation of experimental hybrids	A 49

NON-VIRUS YELLOWS INOCULATED COMPANION TESTS, BLOCK 5 PLANTED MARCH, 1999

2399	72	Evaluation of topcross hybrids	A 64
2499	48	Evaluation of breeding lines	A 39
2599	48	Evaluation of experimental hybrids	A 54

YIELD TRIALS, BLOCK 5, PLANTED MARCH, 1999

2699	48	Evaluation of experimental hybrids	A 57
2799	24	Evaluation of topcross hybrids	A 62
2899	24	Evaluation of population hybrids	A 60
2999	24	Evaluation of monogerm lines & populations	A 45

ERWINIA ROOT ROT/POWDERY MILDEW EVAL., BLOCK 3, PLANTED APRIL 1999

3199-2	21	Evaluation of powdery mildew (USDA entries)	A139
3299	40	CBGA coded powdery mildew	n/a
3399	168	Inheritance of PM resistance	n/a
3499	80	ERR/PM eval. of MM breeding lines	A140
3599	40	ERR/PM eval. of progeny lines	A144
3699	40	ERR/PM eval. of mm populations	A146

TEST NO.	NO. ENTRIES	TEST DESCRIPTION	PAGE NO.
YIELD TRIALS UNDER RHIZOMANIA, BLOCK 2S, PLANTED APRIL 1999			
3999	49	Observation & BNYVV titer	n/a
4099	12	Observation & selection (Seedex)	n/a
4199	12	Observation of Nematode resistance	n/a
4299	60	Evaluation of PI's and Salinas lines	n/a
4399	80	Full-sib progeny from lines with *Bvm* gp	n/a
4499	112	Full-sib progeny from C31*Rz*-type lines	n/a
4599	64	Full-sib progeny from C78 & C80	n/a
4699	80	S_1 progeny from F_1 (MM.S^f.Aa.*Rz*) lines	n/a
4799	48	S_1 progeny from MM.S^f.Aa,*Rz* populations	n/a
4899	128	S_1 progeny from mm.S^1.Aa.*Rz* populations	n/a
4999	24	Performance of populations & lines	A 47
5099	48	WS.BTS.USDA hybrid evaluation (RI-IV)	A 80
5199	78	CBGA coded evaluation (RI-IV)	A 84
5299	18	Population hybrids	n/a
5399	48	Evaluation of MM lines & populations	A 42
5499	48	Evaluation of testcross hybrids	A 68
5599	72	Evaluation of topcross hybrids	A 76
5699	24	Evaluation of population hybrids	A 74
5799	9	Mother root selection	n/a
5899	48	Evaluation of experimental hybrids	A 71
5999	96	S_2 progeny evaluation	n/a
6099	144	Progeny evaluation for homozygosity	n/a
SELECTION FOR RESISTANCE TO RHIZOMANIA & POWDERY MILDEW, BLOCK2M, AUGUST 1999			
6199	57	1999 MM seed productions from gh & isolators	n/a
6299	28	1999 mm seed productions from gh & isolations	n/a
6399	15	1999 seed productions from field isolations	n/a
6499-1	24	1999 increases of selected mm S_1 progeny	n/a
6499-2	48	1999 increases of selected MM S_1 progeny	n/a
6499-3	48	1999 increases of nematode resistant lines	n/a
6499-4	144	S_1 progeny being O-type indexed	n/a

TEST 2199. PERFORMANCE OF LINES UNDER VIRUS YELLOWS INFECTION, 1999

48 entries x 8 reps, RCB(E)
1-row plots, 21 ft. long

Planted: March 22, 1999
Harvested: October 5-7, 1999
Inoc. BYV/BWYV/BChV: June 7, 1999

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Loss %	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	RJAP %	Virus Yellows 07/21	Virus Yellows 08/04	Virus Yellows 08/24	Virus Yellows Mean
2199-1: MM,O.P. lines											
B4035R	Betaseed, 7-10-97	8567	32.0	27.20	15.74	162	83.9	4.5	4.9	6.5	5.2
KW6770	Betaseed,6770.5193,1-10-97	7419	43.5	21.65	17.14	159	85.8	5.4	5.9	7.3	6.0
97-SP22-0	Inc. SP7622-0	3962	61.3	14.50	13.69	159	80.3	5.9	6.0	8.0	6.5
98-EL-04/02	RZM(C80 x EL-smooth root)	7247	41.9	23.77	15.24	160	83.6	5.1	5.1	6.6	5.4
R876-89-5NB	RZM-%S R576-89-5NB	8596	24.8	26.20	16.44	168	84.7	2.9	3.4	4.3	3.3
R881	RZM R776,R781,R781-43, …	10102	16.0	32.25	15.66	156	83.9	3.3	3.5	5.4	4.0
R882	Inc. R776,R781,R781-43, …	9399	24.5	30.50	15.40	155	84.7	3.5	3.6	5.0	4.0
R878%	RZM R778%	9072	29.5	28.10	16.15	152	83.6	3.8	3.9	5.5	4.3
R880	RZM R780	9318	28.4	29.45	15.81	155	83.9	3.9	4.1	5.5	4.5
Y868	RZM Y768	9755	25.5	29.95	16.29	161	84.3	3.8	3.8	5.3	4.2
Y869	RZM Y769,(C69)	9975	21.2	31.05	16.09	146	83.7	3.1	3.1	4.5	3.7
Y871	RZM Y771	9284	31.3	30.50	15.25	161	83.4	3.8	3.9	5.8	4.3
Y872	RZM-%S Y672	9233	26.7	30.25	15.26	162	81.9	3.8	4.3	6.0	4.5
Y872B	RZM Y772,(C72)	9000	28.0	29.20	15.44	160	81.9	4.0	4.6	6.0	4.8
Y875	RZM Y775	9419	24.8	30.15	15.64	151	81.8	3.3	3.6	5.3	4.0
Y875 (Sp)	RZM Y775,Y773,Y772,Y767	9324	28.5	30.00	15.55	152	82.9	3.6	4.1	5.5	4.3
Mean		8729.5	-.-	27.80	15.67	157.4	83.4	4.0	4.2	5.8	4.6
LSD (.05)		756.8	-.-	2.35	0.42	11.8	1.8	0.5	0.5	0.6	0.4
C.V. (%)		8.8	-.-	8.55	2.69	7.6	2.1	13.8	12.2	9.6	8.5
F value		30.6**	-.-	28.77**	24.46**	1.7NS	4.8**	19.2**	22.0**	24.4**	38.2**

TEST 2199. PERFORMANCE OF LINES UNDER VIRUS YELLOWS INFECTION, 1999
48 entries x 8 reps, RCB(E). ANOVA to compare means across sets.

Mean	8490.2	27.42	15.45	158.4	82.8	3.9	4.3	6.0	4.6
LSD (.05)	828.8	2.55	0.45	12.6	1.6	0.6	0.5	0.6	0.4
C.V. (%)	9.9	9.43	2.95	8.0	2.0	14.7	12.7	10.1	8.5
F value	18.7**	15.88**	17.36**	1.2NS	3.9**	11.1**	15.6**	17.8**	27.3**

TEST 2199. PERFORMANCE OF LINES UNDER VIRUS YELLOWS INFECTION, 1999

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Loss %	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	RJAP %	Virus Yellows 07/21	Virus Yellows 08/04	Virus Yellows 08/24	Virus Yellows Mean
2199-2: MM lines with WB germplasm											
SS-432R	Spreckels, 2-8-99	9442	27.5	29.55	16.01	162	82.3	4.4	4.8	5.9	4.9
B4776R	Betaseed 4776R, 1-19-99	8740	39.4	26.55	16.46	161	84.5	5.0	5.9	7.8	6.0
97-US75	Inc. 268 (US75) susc.ck	5337	47.6	20.05	13.31	163	80.3	4.8	5.3	7.8	5.9
97-C37	Inc. U86-37	7191	30.1	23.70	15.13	157	82.0	3.0	2.9	5.8	3.8
P813	Inc.6201-#,6202-#s(C),(CP01)	6937	32.1	23.09	15.02	162	82.7	3.6	4.1	5.6	4.3
P814	Inc.6205-#,6206-#s(C),(CP02)	7227	26.1	23.65	15.26	159	82.0	3.1	3.5	5.5	4.1
R879	RZM R779(C79-1, *Rz*)	6380	32.7	22.33	14.31	146	82.2	3.9	4.5	6.6	4.8
R836	RZM R736, R746 (C79-8,R22)	6982	31.3	24.00	14.56	167	80.5	3.5	3.9	6.9	4.7
R853	RZM-ER-%S R653,(BC_4)	6611	37.3	21.98	15.05	159	82.2	4.3	4.4	6.6	4.9
R854	RZM R754, (BC_5)	7890	27.2	26.15	15.10	161	83.2	3.6	4.1	6.9	4.7
Y873	RZM-ER-%S Y673	8506	31.4	26.80	15.88	158	82.7	3.6	4.1	6.3	4.5
Y873B	RZM Y773	8052	28.2	27.15	14.84	162	82.1	3.9	4.4	6.1	4.7
R840	RZM R740 (C79-#s)	8069	27.0	27.25	14.84	156	82.1	3.8	3.9	6.6	4.7
P811	RZM-PMR 6203-6208-#(C)	8003	31.8	26.80	14.94	163	82.0	3.6	4.1	5.9	4.4
Y866	RZM Y766	8611	30.0	27.25	15.83	151	83.2	4.1	4.4	5.6	4.6
Y867	RZM Y767, (C67)	9253	25.9	29.40	15.74	154	83.7	3.8	3.5	5.0	4.0
Mean		7701.9	-.-	25.36	15.14	158.9	82.4	3.9	4.2	6.3	4.7
LSD (.05)		978.8	-.-	5.35	0.48	11.4	1.6	0.6	0.6	0.6	0.4
C.V. (%)		12.8	-.-	12.14	3.22	7.2	1.9	16.1	13.9	9.2	8.6
F value		10.1**	-.-	6.30**	19.09**	1.7NS	3.5**	5.9**	11.3**	14.6**	16.7**

TEST 2199. PERFORMANCE OF LINES UNDER VIRUS YELLOWS INFECTION, 1999

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Loss %	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	RJAP %	Virus Yellows 07/21	Virus Yellows 08/04	Virus Yellows 08/24	Virus Yellows Mean
2199-3: MM, S^f, Aa populations											
B4419R	Betaseed, 1-19-99	9284	32.1	28.85	16.09	165	84.5	4.9	5.3	7.1	5.6
Rifle	Spreckels, 2-8-99	8104	41.8	25.40	15.95	156	83.1	5.1	6.1	7.6	6.2
8931	RZM 7931,6915,6925(C)aa x A	10635	18.7	34.35	15.49	158	82.5	3.0	3.6	4.6	3.8
Z831	RZM Z731,Z730,Z725(C)aa x A	8769	36.9	27.80	15.76	162	83.1	4.8	4.9	6.3	5.2
8924	RZM 7924, … aa x A	9337	30.9	29.85	15.64	156	83.1	3.9	4.4	5.9	4.7
8926 (Sp)	7931aa x RZM 7926	10256	19.9	33.40	15.38	159	83.1	3.3	3.6	5.3	3.9
8927	RZM 7926, … aa x A	9591	24.9	30.70	15.63	160	82.9	3.6	3.9	5.5	4.3
8932M	7932CT, 7201-7215Maa x A	9035	25.9	28.90	15.64	157	83.1	3.8	4.5	6.6	4.8
P812	RZM-PMR 6211-#-6217-#(C)	9032	29.9	29.65	15.24	155	82.1	3.5	3.4	4.6	3.7
CR811	RZM CR711,(CR09/10)	8319	36.6	27.45	15.16	155	81.9	4.0	4.5	6.5	5.0
CR812	RZM CR712	8347	31.4	26.90	15.51	158	82.2	4.3	4.8	6.6	5.2
CR813	RZM CR713	7944	35.5	27.10	14.69	163	81.2	4.1	4.6	6.6	5.0
N730	Inc. N629, N630 (galls)	7994	30.9	26.61	15.00	159	82.6	4.0	4.6	5.8	4.7
8935	RZM R776-89-5H13	8607	26.0	27.65	15.56	164	81.4	2.9	3.4	5.0	3.7
8936	RZM R776-89-5H31	10036	19.8	31.30	16.04	161	83.4	3.1	3.6	5.0	3.8
8939	RZM Y769H31	9337	26.2	29.98	15.60	155	82.9	3.8	4.0	5.4	4.3
Mean		9039.2	-.-	29.12	15.52	159.0	82.7	3.9	4.3	5.9	4.6
LSD (.05)		719.5	-.-	2.22	0.42	9.6	1.6	0.6	0.5	0.6	0.4
C.V. (%)		8.0	-.-	7.69	2.72	6.1	2.0	14.5	12.0	10.5	8.2
F value		10.1**	-.-	9.62**	6.19**	1.0NS	2.0*	11.0**	16.7**	17.0**	31.5**

Notes: Test 2199 was inoculated with virus yellows (BYV-BWYV-BChV) on June 7, 1999. This is two weeks earlier than tests 2099 and 2299 were inoculated. This helps account for the lower yields and greater estimated yield loss of this test. Relative % loss values were calculated from non-VY test 2499.

TEST 2499. PERFORMANCE OF LINES, SALINAS, CA., 1999

48 entries x 8 reps, RCB(E)
1-row plots, 21 ft. long

Planted: March 24, 1999
Harvested: September 29, 1999

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Bolting %	RJAP %
2499-1: MM,O.P. lines							
B4035R	Betaseed, 7-10-97	13598	40.05	16.98	155	0.4	84.7
KW6770	Betaseed, 6770.5193, 1-10-97	13124	35.60	18.41	152	0.0	85.8
97-SP22-0	Inc. SP7622-0	10240	33.45	15.34	161	0.0	85.5
98-EL-04/02	RZM (C80 x EL-smooth root)	12483	39.95	15.61	156	0.0	84.5
R876-89-5NB	RZM-%S R576-89-5NB (C76-89-5)	11426	33.60	17.02	165	0.0	82.1
R881	RZM R776,R781,R781-43,…, (C82)	12024	38.60	15.61	152	0.0	82.8
R882	Inc. R776,R781,R781-43,… (C82)	12446	39.20	15.81	158	0.0	83.1
R878%	RZM R778%, (C78)	12873	38.53	16.70	150	0.0	84.3
R880	RZM R780, (C90)	13019	39.95	16.29	158	0.0	82.1
Y868	RZM Y768	13088	39.43	16.59	153	0.0	86.1
Y869	RZM Y769, (C69)	12663	38.50	16.42	141	0.0	84.0
Y871	RZM Y771	13509	42.95	15.73	158	0.0	83.8
Y872	RZM-%S Y672	12599	39.30	16.01	162	0.0	83.4
Y872B	RZM Y772, (C72)	12502	39.00	16.05	155	0.0	83.0
Y875	RZM Y775	12532	38.10	16.41	159	0.0	83.7
Y875 (Sp)	RZM Y775, Y773, Y772, Y767	13043	40.00	16.31	155	0.0	83.0
Mean		12573.1	38.51	16.33	155.7	0.02	83.9
LSD (.05)		1117.0	2.84	0.75	9.2	0.25	1.9
C.V. (%)		9.0	7.46	4.62	6.0	1147.90	2.3
F value		4.2**	5.75**	7.76**	3.0**	1.00NS	3.3**

TEST 2499. PERFORMANCE OF LINES, SALINAS, CA., 1999
48 entries x 8 reps, RCB(E). ANOVA across tests to compare means.

Mean	12211.3	37.67	16.19	155.9	0.91	83.8
LSD (.05)	1073.5	2.89	0.68	11.9	1.89	2.0
C.V. (%)	8.9	7.79	4.24	7.7	209.90	2.4
F value	9.7**	7.69**	7.75**	1.5*	24.70**	2.1**

TEST 2499. PERFORMANCE OF LINES, SALINAS, CA., 1999

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Bolting %	RJAP %
2499-2: MM lines with *Bvm* germplasm							
SS-432R	Spreckels, 2-8-99	13029	38.90	16.74	159	0.0	84.1
B4776R	Betaseed 4776R. 1-19-99	14423	41.20	17.49	162	0.0	85.9
97-US75	Inc. 268 (US75) susc. ck	10183	34.25	14.89	162	0.0	83.5
97-C37	Inc. U86-37	10288	32.45	15.85	158	0.0	83.2
P813	Inc. 6201-#, 6202-#s(C), (CP01)	10214	33.05	15.45	161	15.6	84.1
P814	Inc. 6205-#, 6206-#s(C), (CP02)	9781	31.10	15.73	154	9.1	81.6
R879	RZM R779 (C79-1, *Rz*)	9486	32.60	14.56	147	0.0	83.1
R836	RZM R736, R746 (C79-8, R22)	10163	32.85	15.48	168	0.4	82.8
R853	RZM-ER-%S R653, (BC_4)	10539	34.40	15.32	167	0.0	85.5
R854	RZM R754, (BC_5)	10832	34.95	15.43	158	0.0	85.2
Y873	RZM-ER-%S Y673	12403	38.00	16.31	162	0.0	83.4
Y873B	RZM Y773	11217	36.25	15.48	158	0.0	84.0
R840	RZM R740 (C79-#s)	11059	34.85	15.89	155	0.8	83.6
P811	RZM-PMR 6203-6208-#(C)	11737	37.00	15.85	163	15.6	83.2
Y866	RZM Y766	12469	37.45	16.64	146	0.0	83.8
Y867	RZM Y767, (C67)	12495	37.90	16.49	151	0.0	84.1
Mean		11269.8	35.45	15.85	158.2	2.6	83.8
LSD (.05)		1015.0	2.69	0.72	8.5	3.3	2.1
C.V. (%)		9.1	7.68	4.57	5.4	127.4	2.5
F value		14.3**	8.37**	8.34**	4.3**	22.7**	2.0*

TEST 2499. PERFORMANCE OF LINES, SALINAS, CA., 1999

(cont.)

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Bolting	RJAP
		Lbs	Tons	%	No.	%	%
2499-3: MM, S^f, Aa populations							
B4419R	Betaseed, 1-19-99	13663	40.20	17.01	159	0.0	85.4
Rifle	spreckels, 2-8-99	13935	40.60	17.20	153	0.0	83.7
8931	RZM 7931, 6915, 6925(C)aa x A	13089	41.05	15.94	154	0.0	83.4
Z831	RZM Z731, Z730, Z725(C)aa x A	13887	41.70	16.66	153	0.0	84.1
8924	RZM 7924, … aa x A	13512	41.30	16.35	154	0.0	84.4
8926 (Sp)	7931aa x RZM 7926	12807	38.91	16.48	152	0.0	82.5
8927	RZM 7926, … aa x A	12779	40.24	15.86	149	0.9	82.4
8932M	7932CT, 7201-7215Maa x A	12189	36.65	16.63	158	0.0	83.9
P812	RZM-PMR 6211-# - 6217-#(C)	12809	40.13	15.95	158	0.4	83.5
CR811	RZM CR711, (CR09/10)	13130	40.70	16.16	152	0.0	83.9
CR812	RZM CR712	12159	37.15	16.40	154	0.0	84.1
CR813	RZM CR713	12325	38.50	16.00	156	0.0	84.7
N730	Inc. N629, N630 (galls)	11576	35.85	16.15	152	0.8	83.0
8935	RZM R776-89-5H13	11630	34.98	16.64	152	0.0	82.4
8936	RZM R776-89-5H31	12518	38.05	16.46	154	0.0	84.1
8939	RZM Y769H31	12650	38.90	16.27	155	0.0	83.4
Mean		12791.1	39.06	16.39	154.0	0.1	83.7
LSD (.05)		1053.8	3.14	0.53	10.4	0.6	2.0
C.V. (%)		8.3	8.13	3.26	6.8	482.2	2.4
F value		3.7**	3.32**	4.11**	0.5NS	1.8*	1.4NS

Notes: See Test 2199 for performance under virus yellows conditions and Test 5399 for performance under rhizomania conditions. Test 2499 was produced under what appeared to be nearly disease free conditions in soil previously fumigated with methyl bromide for strawberry production. Herbicides were not used.

TEST 5399. PERFORMANCE OF LINES UNDER RHIZOMANIA, SALINAS, CA., 1999

48 entries x 8 reps., RCB(e), 3 sub-sets of 16 x 8, RCB(e)
1-row plots, 22 ft. long

Planted: April 29, 1999
Harvested: October 28, 1999

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Root Rot	RJAP
		Lbs	Tons	%	No.	%	%
5399-1: MM,O.P. lines							
B4776R	Betaseed, 1-19-99	10140	28.67	17.66	190	8.5	87.9
B4430R	Betaseed, 1-10-99	10263	29.14	17.61	204	12.7	87.1
US H11	susc. check	4985	17.58	14.16	173	8.9	86.5
98-EL-04/02	RZM (C80 x EL-smooth root)	7467	23.52	15.85	182	20.8	85.5
R876-89-5NB	RZM-%S R576-89-5NB	7443	21.72	17.20	186	11.3	84.5
R881 (C82)	RZM R776, R781, R781-43, …	8241	25.78	16.00	169	10.6	84.6
R882 (C82)	Inc. R776, R781, R781-43, …	7150	22.43	15.93	181	7.0	87.1
R878% (C78)	RZM R778%	7532	22.74	16.65	174	23.9	85.0
R880 (C80)	RZM R780	8413	25.01	16.84	181	18.8	83.8
Y868	RZM Y768	7258	22.56	16.05	182	21.7	85.3
Y869 (C69)	RZM Y769, (C69)	7685	23.37	16.44	141	14.6	85.8
Y871	RZM Y771	8984	28.19	15.94	169	19.3	85.6
Y872 (C72)	RZM-%S Y672	9899	29.85	16.60	183	12.7	84.4
Y872B	RZM Y772, (C72)	8986	27.65	16.24	185	13.0	83.8
Y875	RZM Y775	7560	23.32	16.19	182	18.9	84.8
Y875 (Sp)	RZM Y775, Y773, Y772, Y767	8029	25.05	15.99	162	20.6	84.4
Mean		8127.2	24.79	16.33	178.1	15.2	85.4
LSD (.05)		956.6	2.74	0.52	15.5	9.7	1.9
C.V. (%)		11.9	11.19	3.20	8.8	64.6	2.3
F value		15.3**	11.27**	19.92**	5.8**	2.4**	3.2**

TEST 5399. PERFORMANCE OF LINES UNDER RHIZOMANIA, SALINAS, CA., 1999
48 entries x 8 reps., RCB(e). ANOVA to compare means across sets of entries.

	Sugar Lbs	Beets Tons	Sucrose %	Beets/100' No.	Root Rot %	RJAP %
Mean	7897.5	24.28	16.23	176.9	16.4	85.0
LSD (.05)	979.6	2.95	0.51	14.9	10.3	2.0
C.V. (%)	12.6	12.35	3.17	8.5	63.8	2.4
F value	10.1**	7.31**	14.35	3.6**	2.4**	2.5**

TEST 5399. PERFORMANCE OF LINES UNDER RHIZOMANIA, SALINAS, CA., 1999

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Root Rot %	RJAP %
5399-2: MM lines with *Bvm* germplasm							
SS-432R	Spreckels, 2-8-99	7632	22.82	16.73	181	6.5	85.3
B4035R	Betaseed, 7-10-97	8518	25.16	16.92	187	11.8	86.7
R827 (C27)	RZM R727A,B	6781	21.09	16.09	173	15.1	86.2
7747	Inc. 5747 (A,aa)	5782	19.64	14.71	177	17.3	86.8
R824	RZM R724,R725(C79-2/3,WB41,42)	6123	19.24	15.93	172	19.2	83.3
R835	RZM R735 (C79-7,SES)	6545	20.38	16.11	186	10.1	85.1
R879	RZM R779 (C79-1, *Rz*)	5399	18.25	14.81	163	23.7	84.6
R836	RZM R736, R746 (C79-8, R22)	7152	23.95	14.88	181	14.0	81.1
R853	RZM-ER-%S R653, (BC_4)	6736	21.26	15.81	175	17.6	85.2
R854	RZM R754, (BC_5)	7254	23.11	15.69	178	18.6	85.4
Y873	RZM-ER-%S Y673	7786	23.87	16.35	189	14.9	84.1
Y873B	RZM Y773	7134	22.29	16.00	174	13.2	84.6
R840	RZM R740 (C79-#s)	8763	27.07	16.24	178	11.0	83.8
P811	RZM-PMR 6203-6208-#(C)	7681	24.16	15.88	186	32.5	83.3
Y866	RZM Y766	9013	27.45	16.41	181	9.8	84.1
Y867	RZM Y767, (C67)	9233	27.47	16.80	182	15.1	85.2
Mean		7345.7	22.95	15.96	179.0	15.7	84.7
LSD (.05)		950.3	2.99	0.57	14.2	11.5	2.3
C.V. (%)		13.1	13.17	3.61	8.0	74.0	2.8
F value		11.2**	7.36**	11.00**	1.8NS	2.3**	2.9**

TEST 5399. PERFORMANCE OF LINES UNDER RHIZOMANIA, SALINAS, CA., 1999

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Root Rot %	RJAP %
5399-3: MM, S^f, Aa populations							
Y869H31	7931aa x Y769	8538	26.21	16.27	173	18.0	84.2
Rifle	Spreckels, 2-8-99	8294	23.34	17.80	170	27.5	85.3
8931	RZM 7931, 6915, 6925(C)aa x A	8966	27.26	16.45	170	15.3	85.3
Z831	RZM Z731, Z730, Z725(C)aa x A	8820	26.33	16.74	166	18.4	85.6
8924	RZM 7924, … aa x A	8841	26.83	16.52	184	14.9	85.1
8926 (Sp)	7931aa x RZM 7926	9223	28.59	16.14	176	17.4	84.3
8927	RZM 7926aa x A	8440	26.36	16.01	187	19.6	85.1
8932M	7932CT, 7201-7215Maa x A	7101	21.77	16.34	176	28.6	84.7
P812	RZM-PMR 6211-# - 6217-#(C)	7822	24.40	16.05	179	19.1	83.9
CR811	RZM CR711, (CR09/10)	8222	25.60	16.02	181	9.4	85.1
CR812	RZM CR712	7803	23.92	16.29	171	15.1	84.8
CR813	RZM CR713	8200	25.94	15.82	159	9.4	84.4
N730	Inc. N629, N630 (galls)	7780	24.47	15.91	168	22.7	84.8
8935	RZM R776-89-5H13	7205	21.64	16.65	179	17.5	85.4
8936	RZM R776-89-5H31	8184	24.30	16.84	184	14.7	84.0
8939	RZM Y769H31	8074	24.47	16.50	155	24.8	86.2
Mean		8219.5	25.09	16.40	173.6	18.3	84.9
LSD (.05)		882.9	2.66	0.42	15.5	9.2	1.8
C.V. (%)		10.9	10.71	2.57	9.0	50.8	2.2
F value		3.6**	4.03**	10.34**	2.6**	2.8**	0.9NS

Notes: Root rot due to *Sclerotium rolfsii*. Roots with obvious rot counted before harvest. Rotted roots weighed at harvest but not included in sugar sample. Root rot caused considerable variability in plot weights.

TEST 2999. EVALUATION OF MONOGERM LINES & POPULATIONS, SALINAS, CA., 1999

24 entries x 4 reps,sequential
1-row plots, 21 ft. long

Planted: March 24, 1999
Harvested: September 20, 1999

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	RJAP %
Checks						
Rifle	Spreckels, 9-16-98	13368	39.50	16.95	156	84.5
B4776R	Betaseed 4776.7653, 3-27-98	14582	41.90	17.44	164	85.7
Monogerm populations						
8810M	RZM 7810NB, (C790 x C890-#)	10204	32.90	15.52	158	82.7
8833	RZM, T-O 7833-#, 7834-# (A,aa)	8626	27.90	15.45	159	82.0
8835	7835,…aa x A	12005	38.40	15.63	151	82.5
8836	T-O 7836-#, 7837-# (A,aa)	10193	31.86	16.01	151	80.2
8838	7838mmaa x A	11254	35.70	15.75	155	82.5
8848M	RZM 7848, (C790 x C890-#)	10799	34.00	15.90	171	82.8
7869NB	NB-RZM 5869	11490	35.10	16.34	163	82.7
8890	RZM 7890(A,aa), (C890-1*Rz*)	10602	33.60	15.76	158	81.4
8932M	7932CT,…aa x A	12032	37.10	16.27	152	82.8
8932H69	6869mmaa x 7932CT, …	12984	41.20	15.75	165	82.2
Monogerm lines & F_1 hybrids						
7869-6	T-O 6869-6	11532	36.30	15.95	173	81.8
8829-3H50	C790-15CMS x 5829-3, (C829-3)	12910	39.40	16.40	167	81.1
8831-3H50	C790-15CMS x 5831-3, (C831-3)	12851	40.30	15.97	163	84.1
8831-4MHO	6831-4HO x 7831-4-#, (C831-4)	13436	42.50	15.85	154	80.5
8833-5HO	C790-15CMS x 5833-5, (C833-5)	12326	36.00	17.13	161	82.3
8833-12H50	C790-15CMS x 5833-12, (C833-12)	12907	39.70	16.24	159	84.7

TEST 2999. EVALUATION OF MONOGERM LINES & POPULATIONS, SALINAS, CA., 1999

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	RJAP %
CMS - monogerm populations						
8833H50	C790-15CMS x RZM,T-O 7833-#	11805	36.00	16.41	159	83.3
8835H50	C790-15CMS x 7835	11592	36.30	15.95	158	82.4
8838H50	C790-15CMS x 7838	12402	38.70	16.02	168	82.7
8836MHO	7838H10 x T-O 7836-#, 7837-#	12976	41.50	15.60	158	82.8
8848HO	7848H88 x RZM 7848	11342	34.70	16.36	164	84.8
8869HO	7869HO x RZM 7869-#(C)	11124	34.92	15.91	167	83.1
Mean		11889.1	36.90	16.11	160.7	82.7
LSD (.05)		1596.3	4.80	0.99	15.1	2.5
C.V. (%)		9.5	9.22	4.34	6.7	2.2
F value		5.2**	4.38**	2.03*	1.3NS	2.2**

TEST 4999. RHIZOMANIA EVALUATION OF MONOGERM POPULATIONS, SALINAS, CA., 1999

24 entries x 8 reps., RCB(e)
1-row plots, 22 ft. long

Planted: April 29, 1999
Harvested: November 1, 1999

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Root Rot	RJAP
		Lbs	Tons	%	No.	%	%
Checks							
Rifle	Spreckels, 2-8-99	7890	22.29	17.65	181	20.6	84.3
B4776R	Betaseed, 1-19-99	9886	27.46	18.01	184	7.6	87.1
Monogerm, S^f,Aa,*Rz* Populations							
0790	8790-S_1(C)aa x A	5309	17.68	14.90	148	18.7	86.1
8808(S_1C)	RZM-% 6808⊗ (Comp 1-10)	5928	18.12	16.38	162	17.0	84.3
8810M	RZM 7810NB, (C790 x C890-#s)	5745	17.83	16.04	173	10.8	84.4
8848M	RZM 7848, (C790 x C890-#s)	6168	19.06	16.19	180	21.1	84.3
8890	RZM 7890 (A,aa),(C890-1*Rz*)	6373	19.23	16.58	166	20.3	84.9
8833	RZM,T-O 7833-#,7834-# (A,aa)	5597	17.54	15.98	171	4.4	83.7
8836	T-O 7836-#,7837-# (A,aa)	5450	17.46	15.54	169	14.6	83.8
7869NB	NB-RZM 5869	7167	21.20	16.90	188	11.2	84.9
8835	7835,…aa x A	6515	19.75	16.50	188	14.1	84.5
8838	7838,…aa x A	6460	19.94	16.20	172	14.1	85.1
8932M	7932CTaa x A	6091	18.58	16.38	175	20.5	84.5
8932H38	7838mmaa x 7932CT	6845	21.06	16.29	173	21.7	85.3
8932H69	6869mmaa x 7932CT	6882	21.12	16.27	180	17.0	84.7
8869HO	7869HO x RZM 7869-#(C)	6625	19.85	16.65	180	17.0	85.4
7818/2M	RZM 6818M (A,aa)	4858	15.53	15.70	177	26.0	84.3
8835H50	C790-15CMS x 7835	6095	18.74	16.27	168	16.9	85.5
8838H50	C790-15CMS x 7838	5958	18.53	15.99	180	24.8	85.3

TEST 4999. RHIZOMANIA EVALUATION OF MONOGERM POPULATIONS, SALINAS, CA., 1999

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Root Rot %	RJAP %
CMSs of Monogerm Lines							
8829-3H50	C790-15CMS x 5829-3 (C829-3)	5785	17.11	16.94	178	20.7	83.6
8831-3H50	C790-15CMS x 5831-3 (C831-3)	7823	23.22	16.86	171	27.8	85.4
8831-4MHO	6831-4MHO x 7831-4-#s (C831-4)	8597	25.48	16.88	164	14.4	83.6
8833-5H50	C790-15CMS x 5833-5 (C833-5)	8585	24.23	17.73	175	23.3	84.4
8833-12H50	C790-15CMS x 5833-12 (C833-12)	7889	23.60	16.71	173	21.5	86.2
Mean		6688.3	20.19	16.48	174.0	17.8	84.8
LSD (.05)		1033.9	2.97	0.61	14.9	11.7	2.0
C.V. (%)		15.7	14.89	3.75	8.7	66.5	2.4
F value		10.8**	7.58**	10.06**	2.7**	1.9*	1.5NS

Notes: Root rot due to *Sclerotium rolfsii*. Roots with obvious rot counted before harvest. Rotted roots weighed at harvest but not included in sugar sample. Root rot caused considerable variability in plot weights.

TEST 2299. PERFORMANCE OF HYBRIDS UNDER VIRUS YELLOWS INFECTION, 1999

48 entries x 8 reps, RCB(E)
1-row plots, 21 ft. long

Planted: March 22, 1999
Harvested: October 4-5, 1999
Inoc. BYV/BChV/BWYV: June 22, 1999

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Loss %	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	RJAP %	Virus Yellows 07/21	Virus Yellows 08/03	Virus Yellows 08/24	Virus Yellows Mean
2299-1: Experimental hybrids											
KW6770	Susc.ck, 6770.5193,1-10-97	9951	25.3	29.30	16.95	168	85.4	4.1	4.8	7.3	5.6
Rifle	Spreckels, 2-8-99	11253	17.2	34.76	16.21	159	82.8	3.6	5.0	7.1	5.5
R876-89-5NBH50	C790-15CMS x RZM-%S R576-89-5NB	11649	16.9	35.90	16.21	164	83.3	3.4	4.9	5.3	4.6
R876-89-5H50	C790-15CMS x RZM-%S R576-89-5	11767	14.1	36.40	16.15	163	82.9	3.6	4.6	4.4	4.3
R882H50	C790-15CMS x R781, R776	11972	14.3	38.40	15.60	161	84.3	3.6	4.8	5.0	4.5
Y869H50	C790-15CMS x Y769	11484	14.9	35.75	16.08	156	84.7	3.8	4.6	4.9	4.4
Y868H50	C790-15CMS x RZM Y768	11411	13.4	35.45	16.05	165	83.7	3.5	5.0	4.5	4.3
R878H50 (Iso)	C790-15CMS x RZM R778%	11438	19.4	35.65	16.00	169	84.0	3.6	4.6	5.5	4.7
Y866H50	C790-15CMS x RZM Y766	11047	21.5	34.25	16.13	170	83.9	4.5	4.5	5.5	4.8
Y867H50	C790-15CMS x RZM Y767	12084	12.5	37.67	16.02	165	83.2	4.0	4.4	5.0	4.6
Y871H50	C790-15CMS x RZM Y771	12344	10.7	39.05	15.81	171	83.6	3.6	4.6	5.6	4.6
Y872H50	C790-15CMS x RZM-%S Y672	11889	15.7	38.35	15.56	164	80.9	3.8	5.3	5.4	4.8
Y872BH50	C790-15CMS x RZM Y772	11991	7.7	37.55	16.00	168	84.1	4.3	4.5	6.0	5.0
Y875H50 (Iso)	C790-15CMS x RZM Y775	11735	12.5	36.40	16.11	167	84.1	3.8	4.6	4.9	4.4
Y873BH50	C790-15CMS x RZM Y773	10390	21.7	33.75	15.42	166	82.6	4.1	4.3	5.9	4.8
R854H50	C790-15CMS x RZM R754	11657	8.7	36.83	15.82	164	83.1	3.8	4.8	6.4	4.9
Mean		11503.8	-.-	35.97	16.01	165.1	83.5	3.8	4.7	5.5	4.7
LSD (.05)		1003.4	-.-	2.88	0.57	9.3	2.0	0.6	0.6	0.6	0.4
C.V. (%)		8.8	-.-	8.08	3.62	5.7	2.5	17.1	13.2	10.9	7.7
F value		3.0**	-.-	5.17**	2.85**	1.5NS	2.0*	1.7NS	1.3**	15.3**	8.7**

TEST 2299. PERFORMANCE OF HYBRIDS UNDER VIRUS YELLOWS INFECTION, 1999
48 entries x 8 reps, RCB(E). ANOVA across tests to compare means.

Mean	11533.1	-.-	36.17	15.95	161.5	83.6	3.8	4.7	5.5	4.7
LSD (.05)	1011.1	-.-	2.97	0.51	10.2	1.8	0.6	0.6	0.6	0.4
C.V. (%)	8.9	-.-	8.33	3.27	6.4	2.2	16.3	13.6	11.2	8.2
F value	2.8**	-.-	3.26**	2.96**	5.7**	1.7**	2.8**	1.2NS	9.9**	6.3**

TEST 2299. PERFORMANCE OF HYBRIDS UNDER VIRUS YELLOWS INFECTION, 1999

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Loss %	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	RJAP %	Virus Yellows 07/21	Virus Yellows 08/03	Virus Yellows 08/24	Virus Yellows Mean
2299-2: Hybrids with populations											
B4776R	Betaseed, 1-19-99	12458	17.0	36.75	16.95	166	85.5	3.8	4.8	7.0	5.3
SS-432R	Spreckels, 2-8-99	10867	14.2	33.65	16.13	160	83.4	4.5	4.9	6.8	5.4
8913-70H50	C790-15CMS x RZM-ER-% 6913-70	11120	21.7	34.75	15.99	163	83.6	3.3	4.8	4.6	4.1
R882H38	7838mmaa x R781, R776	11221	11.7	35.82	15.69	148	84.2	3.1	4.8	5.6	4.6
8931H50	C790-15CMS x RZM 7931	11652	18.8	37.50	15.59	172	82.5	3.9	4.4	5.4	4.5
8924H50	C790-15CMS x RZM 7924	11832	7.9	37.30	15.88	167	84.2	3.6	4.8	5.8	4.7
8932H50	C790-15CMS x 7932CT, …	11634	10.7	36.65	15.86	170	83.1	3.9	5.1	5.6	4.9
Z831H50	C790-15CMS x RZM Z730,Z731	11125	21.1	34.90	15.95	165	83.8	3.8	4.8	5.8	4.8
8926H50 (Sp)	C790-15CMS x RZM 7926	11602	12.7	36.35	15.95	170	83.5	4.3	5.0	5.3	4.8
8935H50 (Iso)	C790-15CMS x RZM R776-89-5H13	11607	12.7	35.70	16.25	167	82.4	3.5	4.4	4.9	4.3
8936H50	C790-15CMS x RZM R776-89-5H31	12740	10.4	39.50	16.13	163	83.3	3.1	4.4	5.1	4.3
8937H50	C790-15CMS x RZM R776-89-5H11	12462	10.2	38.32	16.25	168	84.1	3.8	4.3	5.0	4.4
8938H50	C790-15CMS x RZM Z731H11	12218	10.5	38.55	15.84	168	82.8	3.8	4.4	5.4	4.6
8939H50	C790-15CMS x RZM Y769H31	11611	15.7	37.35	15.55	163	84.0	4.3	4.5	5.1	4.6
CR812H50	C790-15CMS x RZM CR712	11902	14.9	37.15	15.99	170	84.2	3.9	4.5	6.3	4.9
CR813H50	C790-15CMS x RZM CR713	12147	13.0	39.00	15.57	167	83.5	3.5	4.6	5.8	4.7
Mean		11762.3	-.-	36.83	15.97	165.5	83.6	3.7	4.6	5.6	4.7
LSD (.05)		1059.6	-.-	3.17	0.48	10.7	1.7	0.6	0.7	0.6	0.4
C.V. (%)		9.1	-.-	8.69	3.02	70.3	2.0	17.3	14.1	11.4	8.6
F value		2.0*	-.-	2.02*	4.03**	2.2**	1.6NS	2.9**	1.2NS	8.3**	5.8**

TEST 2299. PERFORMANCE OF HYBRIDS UNDER VIRUS YELLOWS INFECTION, 1999

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Loss %	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	RJAP %	Virus Yellows 07/21	Virus Yellows 08/03	Virus Yellows 08/24	Virus Yellows Mean
2299-3: Topcross hybrids											
B4035R	Betaseed, 7-10-97	10762	16.5	34.00	15.84	165	83.5	4.4	4.4	6.4	5.2
B4419R	Betaseed, 1-19-99	11993	16.2	36.80	16.26	167	85.0	3.5	4.6	6.8	5.2
8931H38	7838mmaa x RZM 7931	11520	15.5	36.20	15.90	156	84.7	4.3	4.6	5.4	4.8
8935H38	7838mmaa x R776-89-5H13	11989	6.1	37.45	16.01	155	84.1	3.6	4.4	4.8	4.3
Y869H38	7838mmaa x Y769	11408	10.3	35.70	15.98	156	83.5	4.1	4.4	5.0	4.4
Y869H35	7835aa x Y769	11444	10.4	36.35	15.76	154	82.4	4.3	4.8	5.5	4.9
Y869H69	7869aa x Y769	9961	24.5	32.83	15.21	157	83.2	4.0	4.9	5.3	4.7
Y869H46	7869-6HO x Y769	10941	14.3	35.00	15.63	161	83.9	3.6	4.4	5.3	4.5
Y869H4	C831-3aa x Y769	10061	16.9	32.16	15.65	131	84.1	4.1	4.3	5.1	4.5
Y869H5	C833-5aa x Y769	11736	17.3	36.84	15.94	158	82.6	3.4	4.3	5.9	4.6
Y869H12	C833-12aa x Y769	11246	18.2	35.22	15.93	135	84.3	4.3	4.6	6.0	5.0
Y869H27	C831-4HO x Y769	11810	14.5	37.10	15.93	159	84.4	3.3	4.8	4.6	4.2
Y869H29	C829-3aa x Y769	11309	5.2	34.75	16.27	158	82.7	3.1	4.5	6.0	4.7
Y869H45	C867-1HO x Y769	11309	8.7	35.85	15.79	155	83.6	4.3	4.8	5.6	4.9
Y869H7	C911-4-7HO x Y769	11785	16.0	36.59	16.10	143	83.8	3.5	4.6	4.9	4.2
R882H27	C831-4HO x R781, R776 (C82)	12057	12.4	38.45	15.70	150	83.2	3.6	5.1	5.3	4.7
Mean		11333.1	-.-	35.71	15.87	153.8	83.7	3.8	4.6	5.5	4.7
LSD (.05)		968.2	-.-	2.94	0.44	10.4	1.8	0.6	0.6	0.6	0.4
C.V. (%)		8.6	-.-	8.31	2.78	6.8	2.2	14.9	14.2	10.2	7.8
F value		3.4**	-.-	2.54**	2.74**	6.9**	1.4NS	4.3**	1.1NS	9.0**	5.9**

Notes: Test 2299 was inoculated with virus yellows (BYV-BWYV-BChV) on June 22, 1999. Relative % loss values were calculated in comparison to noninoculated companion Test 2599 (see Test 2599).

TEST 2099. PERFORMANCE OF S_1 TOPCROSS HYBRIDS UNDER VIRUS YELLOWS INFECTION, 1999

24 entries x 4 reps, RCB(E)
1-row plots, 21 ft. long

Planted: March 22, 1999
Harvested: October 4, 1999
Inoc. BYV/BWYV/BChV: June 22, 1999

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	RJAP	Virus Yellows			
		Lbs	Tons	%	No.	%	08/05	08/16	08/24	Mean
Checks										
Rifle	Spreckels, 9-98, L1162401	9866	29.80	16.55	170	84.6	5.0	6.0	7.8	6.3
B4776R	Beta 4776R.7653, 3-27-98	11277	33.50	16.84	159	86.2	4.8	5.8	7.5	6.0
Y869H50	C790-15CMS x Y769	11154	34.80	16.04	158	83.6	4.3	4.0	5.0	4.4
Topcross to S_1's from popn-869										
Y869H69	7869aa x Y769	10644	33.70	15.79	156	84.0	5.0	5.0	6.3	5.4
Y869H46	7869-6HO x Y769	10410	32.90	15.79	159	84.4	4.8	5.0	6.3	5.3
Y869H69-2	7869-2aa x Y769	10268	33.80	15.20	151	83.2	4.0	4.5	5.3	4.6
Y869H69-4	7869-4aa x Y769	10622	33.30	15.95	146	84.3	5.0	5.3	6.8	5.7
Y869H69-20A	7869-20aa x Y769	9902	32.30	15.34	150	83.9	5.3	5.0	6.3	5.5
Y869H69-20B	7869-20Baa x Y769	9676	30.80	15.69	142	84.3	5.0	4.8	5.8	5.2
Y869H69-24	7869-24aa x Y769	10500	32.60	16.10	158	85.0	4.5	4.5	6.0	5.0
Topcrosses to S_1's from popn-833										
Y869H5	5833-5aa (C833-5) x Y769	11727	36.53	16.05	137	82.7	3.5	4.0	6.0	4.5
Y869H33-3	7833-3aa x Y769	10614	34.70	15.32	157	83.8	5.0	5.3	6.8	5.7
Y869H33-10	7833-10aa x Y769	11237	34.20	16.41	165	83.8	4.3	4.3	5.0	4.5
Y869H33-12	7833-12aa x Y769	10466	33.15	15.80	148	84.0	5.3	5.8	7.3	6.1

TEST 2099. PERFORMANCE OF S_1 TOPCROSS HYBRIDS UNDER VIRUS YELLOWS INFECTION, 1999

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	RJAP %	Virus Yellows 08/05	Virus Yellows 08/16	Virus Yellows 08/24	Virus Yellows Mean
Topcrosses to S_1's from popn-831-4										
Y869H27	6831-4HO(C831-4CMS) x Y769	11137	35.30	15.79	150	83.4	4.0	4.3	5.3	4.5
Y869H27-1	7831-4-1 x Y769	9617	30.70	15.69	129	83.1	4.8	5.3	6.0	5.3
Y869H27-7	7831-4-7aa x Y769	11481	36.40	15.77	161	82.1	4.0	4.8	5.8	4.8
Y869H27-8	7831-4-8aa x Y769	10438	33.30	15.66	158	83.9	4.8	5.3	6.5	5.5
Y869H27-10	7831-4-10aa x Y769	11896	37.13	16.04	149	82.3	3.8	4.3	5.8	4.6
Topcrosses to S_1's from popn-834										
Y869H34-2	7834-2aa x Y769	9184	28.60	16.08	145	83.3	5.5	5.0	6.0	5.5
Y869H34-8	7834-8aa x Y769	9890	31.81	15.51	146	83.9	5.3	5.3	6.3	5.6
Topcrosses to S_1's from popn-836										
Y869H36-3	7836-3aa x Y769	9585	30.70	15.64	132	84.0	4.3	5.0	6.5	5.3
Topcrosses to S_1's from popn-839										
Y869H79-2	7839-2aa x Y769	10419	33.60	15.54	154	84.1	4.8	5.0	6.3	5.3
Y869H79-3	7839-3aa x Y769	9839	31.80	15.49	159	84.7	5.8	5.8	7.3	6.3
Mean		10493.7	33.14	15.84	151.7	83.9	4.7	4.9	6.2	5.3
LSD (.05)		927.0	2.70	2.49	20.3	1.5	0.8	0.7	0.7	0.5
C.V. (%)		6.3	5.77	1.76	9.5	1.3	11.5	10.3	7.9	6.8
F value		4.9**	4.93**	7.73**	2.0*	2.6**	4.6**	4.8**	8.9**	10.1**

Notes: See Tests B799, 999, 2399, & 5599. These entries tested under virus yellows are an abbreviated list from the above tests.

TEST 2599. PERFORMANCE OF HYBRIDS, SALINAS., CA, 1999

48 entries x 8 reps, RCB(E)
1-row plots, 21 ft. long

Planted: March 24, 1998
Harvested: September 24, 1999

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Root Rot %	RJAP %
2599-1: Experimental hybrids							
KW6770	Susc. check, 6770.5193, 1-10-97	13315	36.35	18.36	158	0.0	85.5
Rifle	Spreckels, 2-8-99	13594	38.60	17.60	150	0.4	84.5
R876-89-5NBH50	C790-15CMS x RZM-%S R576-89-5NB	14029	40.70	17.24	158	0.0	84.5
R876-89-5H50	C790-15CMS x RZM-%S R576-89-5	13706	41.10	16.67	162	0.0	83.0
R882H50	C790-15CMS x R781, R776, (C82)	13968	43.25	16.14	158	0.0	85.3
Y869H50	C790-15CMS x Y769, (C69)	13491	41.35	16.33	151	0.0	85.3
Y868H50	C790-15CMS x RZM Y768	13173	42.30	15.57	160	0.4	84.3
R878H50 (Iso)	C790-15CMS x RZM R778%, (C78)	14199	41.96	16.91	163	0.0	85.1
Y866H50	C790-15CMS x RZM Y766	14077	41.70	16.88	162	0.3	85.3
Y867H50	C790-15CMS x RZM Y767, (C67)	13802	41.35	16.73	158	0.0	84.1
Y871H50	C790-15CMS x RZM Y771	13823	42.90	16.10	163	0.0	85.0
Y872H50	C790-15CMS x RZM-%S Y672, (C72)	14111	42.90	16.45	155	0.0	84.2
Y872BH50	C790-15CMS x RZM Y772	12987	39.30	16.49	162	0.0	84.3
Y875H50 (Iso)	C790-15CMS x RZM Y775	13411	41.30	16.25	159	0.0	85.1
Y873BH50	C790-15CMS x RZM Y773	13275	41.40	16.05	157	0.0	83.9
R854H50	C790-15CMS x RZM R754	12768	39.55	16.13	155	0.0	84.5
Mean		13608.1	41.00	16.62	158.3	0.1	84.6
LSD (.05)		1014.6	2.49	0.59	10.6	0.5	1.9
C.V. (%)		7.5	6.14	3.58	6.7	671.9	2.2
F value		1.4NS	4.07**	10.51**	23.7NS	0.8NS	1.0NS

TEST 2599. PERFORMANCE OF HYBRIDS, 1999
48 entries x 8 reps. RCB(E). ANOVA to compare means across sets.

	Sugar Lbs	Beets Tons	Sucrose %	Beets/100' No.	Root Rot %	RJAP %
Mean	13493.9	41.08	16.43	155.6	0.05	84.5
LSD (.05)	1027.0	2.77	0.58	11.5	0.36	1.7
C.V. (%)	7.7	6.84	3.60	7.5	802.14	2.1
F value	3.1**	3.56**	5.90**	4.8**	0.89NS	1.6**

TEST 2599. PERFORMANCE OF HYBRIDS, SALINAS., CA, 1999

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Root Rot %	RJAP %
2599-2: Hybrids with MM, S^f,Aa populations							
B4776R	Betaseed, 1-19-99	15006	42.20	17.79	156	0.0	86.7
SS-432R	Spreckels, 2-8-99	12668	38.75	16.34	162	0.0	83.9
8913-70H50	C790-15CMS x RZM-ER-% 6913-70	14195	43.55	16.30	164	0.0	83.5
R882H38	7838mmaa x R781, R776	12705	39.85	15.94	148	0.0	83.7
8931H50	C790-15CMS x RZM 7931	14349	43.90	16.35	156	0.0	84.3
8924H50	C790-15CMS x RZM 7924	12849	39.45	16.26	156	0.0	84.8
8932H50	C790-15CMS x 7932CT, …	13023	39.80	16.36	166	0.0	83.9
Z831H50	C790-15CMS x RZM Z730, Z731	14103	42.45	16.61	159	0.0	84.1
8926H50 (Sp)	C790-15CMS x RZM 7926	13289	41.45	16.01	156	0.4	84.9
8935H50 (Iso)	C790-15CMS x RZM R776-89-5H13	13298	40.80	16.27	156	0.0	85.2
8936H50	C790-15CMS x RZM R776-89-5H31	14221	42.40	16.79	161	0.4	83.5
8937H50	C790-15CMS x RZM R776-89-5H11	13880	42.55	16.34	156	0.0	84.4
8938H50	C790-15CMS x RZM Z731H11	13657	42.11	16.21	154	0.0	84.3
8939H50	C790-15CMS x RZM Y769H31	13778	42.75	16.09	161	0.0	84.6
CR812H50	C790-15CMS x RZM CR712	13980	42.75	16.35	163	0.0	83.8
CR813H50	C790-15CMS x RZM CR713	13966	43.50	16.05	165	0.0	84.4
Mean		13685.4	41.77	16.38	158.7	0.05	84.4
LSD (.05)		904.4	2.44	0.61	9.8	0.38	1.7
C.V. (%)		6.7	5.90	3.78	6.2	801.64	2.1
F value		4.2**	3.29**	3.87**	1.8*	0.91NS	1.6NS

TEST 2599. PERFORMANCE OF HYBRIDS, SALINAS., CA, 1999

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Root Rot %	RJAP %
2599-3: Topcross hybrids							
B4035R	Betaseed, 7-10-97	12891	39.10	16.46	166	0.3	83.9
B4419R	Betaseed, 1-19-99	14303	42.30	16.91	162	0.0	85.3
8931H38	7838mmaa x RZM 7931	13638	42.15	16.17	147	0.0	85.4
8935H38	7838mmaa x R776-89-5H13	12763	38.85	16.42	156	0.0	84.5
Y869H38	7838mmaa x Y769	12723	39.55	16.09	148	0.0	85.1
Y869H35	7835aa x Y769	12770	39.45	16.19	159	0.0	83.3
Y869H69	7869aa x Y769	13201	40.45	16.30	157	0.0	85.6
Y869H46	7869-6HO x Y769	12768	39.60	16.14	153	0.0	84.6
Y869H4	C831-3aa x Y769	12100	38.27	15.81	111	0.0	84.5
Y869H5	C833-5aa x Y769	14198	42.05	16.90	158	0.0	82.8
Y869H12	C833-12aa x Y769	13745	41.65	16.51	137	0.0	84.8
Y869H27	C831-4HO x Y769	13809	43.00	16.06	156	0.0	83.8
Y869H29	C829-3aa x Y769	11925	36.65	16.29	150	0.0	83.0
Y869H45	C867-1HO x Y769	12382	38.00	16.29	147	0.0	84.7
Y869H7	C911-4-7HO x Y769	14031	43.40	16.14	145	0.0	83.1
R882H27	C831-4HO x R781, R776	13766	43.30	15.91	147	0.0	85.2
Mean		13188.3	40.49	16.29	149.9	0.02	84.4
LSD (.05)		1105.0	3.17	0.49	11.0	0.24	1.6
C.V. (%)		8.5	7.92	3.05	7.4	1116.24	1.9
F value		3.6**	3.41**	3.00**	10.8**	0.99NS	2.5**

Notes: See Test 2299 for performance under virus yellows conditions. Tests 2099 thru 2999 were grown following strawberries. Prior to strawberry, the soil had been fumigated with methyl bromide. Therefore, few root problems were experienced in these trials. Damping-off was not observed and BNYVV and SBCN should have been at very low levels. Powdery mildew was controlled as needed as were aphids and other insects. Except for mild infestation of black aphids, there was little evidence of insect damage. It was not necessary to use herbicides. The plot area was sprinkler irrigated at least weekly and wilting rarely occurred; i.e. these tests were grown with minimal stress. Under these conditions, the most important factor for sugar yield (other than experimental error) should have been their genetic potential to accumulate sucrose. Under these conditions, these tests should have been good at measuring the genetic potential of these materials. Sugar yield of up to 15000 lbs/a for less than 6 months are quite remarkable.

TEST 2699. EVALUATION OF EXPERIMENTAL HYBRIDS, SALINAS, CA., 1999

48 entries x 8 reps, RCB(E)
1-row plots, 21 ft. long

Planted: March 24, 1999
Harvested: September 22-24, 1999

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	RJAP %
2699-1: Experimental hybrids with S_1 pollinators						
SS-432R	Spreckels, 2-8-99	12922	39.40	16.40	157	84.0
Rifle	Spreckels, 2-98, L1162401	14374	41.60	17.29	161	83.9
B4776R	Betaseed 4776R.7653 (3-27-98)	14911	41.35	18.02	156	85.7
8931H50	C790-15CMS x RZM 7931	13288	40.90	16.24	161	83.6
8925-19H50	C790-15CMS x 6925-19	14773	45.55	16.24	156	85.3
8913-70H50	C790-15CMS x RZM-ER-%S 6913-70	13953	41.70	16.74	158	83.1
8911-4-10H50	C790-15CMS x RZM-ER-%S 6911-4-10	14840	43.30	17.13	159	81.5
8918-12H50	C790-15CMS x RZM-ER-%S 6918-12	14342	44.95	15.96	151	84.1
8918-21H50	C790-15CMS x RZM 7918-21	14145	44.20	16.01	148	85.1
Z825-6H50	C790-15CMS x Z625-6	15069	44.85	16.79	165	83.2
Z825-9H50	C790-15CMS x Z625-9	15044	41.26	18.21	157	85.1
Z830-11H50	C790-15CMS x Z630-11	14709	45.40	16.23	155	84.1
R709-1H50	C790-15CMS x CR-RZM R509A-1	14377	42.45	16.96	156	83.4
CR812H50	C790-15CMS x RZM CR712	13510	41.80	16.16	158	83.9
CR813H50	C790-15CMS x RZM CR713	14182	44.00	16.10	162	84.9
R709-9H50	C790-15CMS x CR-RZM R509A-9	14706	46.45	15.86	165	85.8
Mean		14321.4	43.07	16.65	157.9	84.2
LSD (.05)		1368.7	3.81	0.58	10.5	1.5
C.V. (%)		9.7	8.94	3.50	6.7	1.8
F value		1.7NS	2.24**	12.15**	1.5NS	4.3**

TEST 2699. EVALUATION OF EXPERIMENTAL HYBRIDS, 1999
48 entries x 8 reps, RCB(E). ANOVA to compare means across sets of entries.

Mean	14041.7	42.67	16.46	155.7	84.2
LSD (.05)	1321.4	3.61	0.62	11.0	1.6
C.V. (%)	9.6	8.58	3.84	7.2	2.0
F value	2.2**	1.90**	6.17**	1.4NS	2.0**

TEST 2699. EVALUATION OF EXPERIMENTAL HYBRIDS, SALINAS, CA., 1999

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	RJAP %
2699-2: S_1 pollinators from MM,VY,S^f,Aa,Rz popns						
R878H50	C790-15CMS x R778, R778%	13129	40.00	16.41	144	83.8
8930-19H50	C790-15CMS x 6930-19	14744	43.85	16.81	156	84.6
8930-39H50	C790-15CMS x 6930-39	14356	43.95	16.30	160	84.5
8930-102H50	C790-15CMS x 6930-102	14107	42.45	16.64	158	83.1
R882H50	C790-15CMS x R781, R776	14106	44.10	15.96	146	84.7
R876-89-5H50	C790-15CMS x RZM-%S R576-89-5	14662	44.45	16.49	154	84.3
8929-41H50	C790-15CMS x 6929-41	14523	43.60	16.65	159	84.1
8929-72H50	C790-15CMS x 6929-72	14082	43.30	16.25	158	84.8
8929-102H50	C790-15CMS x 6929-102	14039	42.85	16.39	155	83.5
8929-112H50	C790-15CMS x 6929-112	14236	41.50	17.14	159	83.6
8929-114H50	C790-15CMS x 6929-114	14985	45.05	16.63	152	84.3
8929-115H50	C790-15CMS x 6929-115	13970	40.90	17.08	151	84.0
8929-133H50	C790-15CMS x 6929-133	12993	39.30	16.56	152	84.3
8929-153H50	C790-15CMS x 6929-153	13639	41.75	16.34	157	84.6
8929-154H50	C790-15CMS x 6929-154	15489	46.45	16.68	154	83.8
8924H50	C790-15CMS x RZM 7924	14137	42.45	16.65	158	84.3
Mean		14199.9	42.87	16.56	154.5	84.1
LSD (.05)		1204.3	3.18	0.53	10.6	1.5
C.V. (%)		8.6	7.48	3.22	7.0	1.8
F value		2.1*	2.73**	2.49**	1.5NS	0.8NS

TEST 2699. EVALUATION OF EXPERIMENTAL HYBRIDS, SALINAS, CA., 1999

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	RJAP %
2699-3: Lines & S_1 pollinators from MM,S^f,Aa,R22 popns						
4035R	Betaseed, 7-10-97	13763	42.25	16.27	161	84.0
Rizor	Holly HH108, 9-3-97	14558	42.30	17.20	156	84.5
Y869H50	C790-15CMS x Y769	14284	43.70	16.33	148	84.7
R835H50	C790-15CMS x RZM R735 (C79-7)	13128	40.45	16.20	151	84.1
R836H50	C790-15CMS x RZM R736, R746 (C79-8)	13232	41.95	15.79	149	83.8
Y873BH50	C790-15CMS x RZM Y773	12854	40.70	15.79	163	84.5
R879H50	C790-15CMS x RZM R779 (C79-1)	12679	41.65	15.23	155	84.4
Y867H50	C790-15CMS x RZM Y767 (C67)	13724	42.60	16.06	155	85.0
Y872H50	C790-15CMS x RZM-%S Y672	13762	43.30	15.90	157	83.8
Y875H50	C790-15CMS x RZM Y775, …	12596	39.60	15.85	154	85.2
8926H50 (Sp)	C790-15CMS x RZM 7926, …	13847	42.70	16.24	151	83.3
8926H50 (Iso)	C790-15CMS x RZM 7926	13306	41.95	15.86	159	84.0
8927-29H50	C790-15CMS x 6927-29	14514	42.85	16.91	156	83.9
8927-30H50	C790-15CMS x 6927-30	13105	40.65	16.15	152	82.1
8927-33H50	C790-15CMS x 6927-33	13770	41.55	16.55	150	83.8
8927-37H50	C790-15CMS x 6927-37	14542	44.70	16.27	159	85.2
Mean		13603.9	42.06	16.16	154.7	84.1
LSD (.05)		1398.7	3.79	0.67	10.1	1.9
C.V. (%)		10.4	9.11	4.17	6.6	2.3
F value		1.7NS	0.93NS	3.85**	1.5NS	1.3NS

Notes: C790-15CMS was used as a common tester to evaluate the general combining ability of S_1 progeny lines extracted from multigerm, self-fertile, genetic-male-sterile facilitated random-mated populations. In general, S_o plants from populations were selected for resistance to rhizomania and/or virus yellows and selfed to produce multigerm, S_1 progeny lines. These S_1 lines were evaluated per se for bolting, tendency, disease resistance, and components of sugar yield. The best S_1 lines were selected, increased in isolation, and crossed to the tester C790-15CMS to produce testcross hybrids. Based upon the performance of these hybrids in tests in Imperial Valley and Salinas, the superior progeny lines will be reselected for further evaluation, improvement, and recombination.

TEST 2899. EVALUATION OF POPULATION HYBRIDS, SALINAS, CA., 1999

24 entries x 8 reps, RCB(E)
1-row plots, 21 ft. long

Planted: March 24, 1999
Harvested: September 21, 1999

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Root Rot	RJAP
		Lbs	Tons	%	No.	%	%
Checks							
Rifle	Spreckels, 9-16-98	13754	38.05	18.05	151	0.7	85.3
B4776R	Betaseed 4776.7653, 3-27-98	14814	41.70	17.79	162	0.0	84.7
Population hybrids							
R878H50(Sp)	C790-15CMS x R778, R778% (C78)	13532	41.40	16.34	154	0.0	83.8
R878H55	7835H50 x R778, %	13212	40.95	16.14	163	0.0	84.0
R878H58	7838H50 x R778, %	13304	41.40	16.08	140	0.0	83.6
R878H69	7869aa x R778, %	13542	42.25	16.02	152	0.0	84.9
R876-89-5NBH50	C790-15CMS x RZM-% R576-89-5NB	13258	40.45	16.39	161	0.0	84.4
R882H50	C790-15CMS x R781, R776 (C82)	13330	41.90	15.89	158	0.0	84.2
R882H55	7835H50 x R781, R776	13826	44.45	15.55	155	0.0	84.3
R882H58	7838H50 x R781, R776	13707	43.00	15.94	153	0.4	82.7
Y875H55	7835H50 x RZM Y775, …	13314	41.35	16.10	155	0.4	84.3
Y875H58	7838H50 x RZM Y775, …	13291	41.10	16.16	153	0.0	83.1
8931H50	C790-15CMS x RZM 7931, …	14744	45.45	16.21	159	0.0	83.6
8931H38	7838mmaa x RZM 7931, …	13256	41.05	16.16	155	0.0	83.1
8932H38	7838mmaa x RZM 7932CT, …	13657	42.80	15.94	151	0.0	82.7
8935H38	7838mmaa x R776-89-5H13	14074	42.55	16.54	156	0.0	83.5
8935H50	C790-15CMS x R776-89-5H13	14828	43.40	17.08	147	0.0	85.3
8936H50	C790-15CMS x RZM R776-89-5H31	14338	43.30	16.56	156	0.0	83.2
8937H50	C790-15CMS x RZM R776-89-5H11	13889	43.00	16.13	162	0.0	83.5
8938H50	C790-15CMS x RZM Z731H11	14239	43.75	16.26	157	0.0	84.5

TEST 2899. EVALUATION OF POPULATION HYBRIDS, SALINAS, CA., 1999

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Root Rot %	RJAP %
Population hybrids (cont.)							
8939H50	C790-15CMS x RZM Y769H31	13823	43.85	15.76	148	0.0	81.4
Z831H50	C790-15CMS x RZM Z730, Z731	14396	44.30	16.29	146	0.0	82.9
Z831H55	7835H50 x RZM Z730, Z731	14067	43.45	16.16	145	0.0	84.3
Z831H58	7838H50 x RZM Z730, Z731	14158	42.20	16.77	154	0.0	83.5
Mean		13848.0	42.38	16.35	153.8	0.1	83.8
LSD (.05)		1152.2	2.94	0.73	14.5	0.5	2.2
C.V. (%)		8.5	7.04	4.51	9.6	820.1	2.7
F value		1.6NS	2.23*	4.97**	1.2NS	0.9NS	1.3NS

Notes: Much of the breeding program at Salinas involves population improvement. Populations may be conventional self-sterile, open-pollinated lines such as C78, C69, etc., or self-fertile, genetic-male-sterile facilitated, random-mated populations. Both multigerm and monogerm self-fertile populations have been developed. The multigerm populations are generally numbered in the 900-series, e.g. popn-931, and the monogerms in the 800-series, e.g., popn-869. Test 2899's purpose was to determine in general the performance traits of various populations and to determine which populations combine well together. Populations that show good performance may then be chosen as a source of progeny lines, e.g., S_1 progenies. Various types of intra-population improvement (e.g., mass and recurrent selection) and modified interpopulation improvement (e.g., reciprocal recurrent selection) can be done. The major thrust continues to be to develop source populations with useful combinations of disease resistance and tolerance.

TEST 2799. EVALUATION OF TOPCROSS HYBRIDS, SALINAS, CA., 1999

24 entries x 8 reps, RCB(e)
1-row plots, 21 ft. long

Planted: March 24, 1999
Harvested: September 21, 1999

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	RJAP %
Checks						
B4776R	Betaseed 4776.7653, 3-27-98	13972	39.45	17.70	158	85.5
Rifle	Spreckels, 9-16-98	13577	38.95	17.44	156	84.6
Topcrosses to released mm lines						
Y869H50	C790-15CMS x Y769	13315	42.14	15.75	152	84.3
Y869H4	5831-3aa (C831-3) x Y769	12235	38.47	15.91	102	83.0
Y869H5	5833-5aa (C833-5) x Y769	13584	40.40	16.81	141	83.1
Y869H7	6911-4-7HO (C911-4-7) x Y769	12655	40.75	15.52	148	83.3
R678H33-5	5833-5aa (C833-5) x R578	14383	40.70	17.64	134	84.4
Y869H27	6831-4HO (C831-4) x Y769	13574	42.90	15.79	154	84.7
Y869H29	5829-3aa (C829-3) x Y769	12636	39.35	16.06	145	81.9
Y869H45	7867-1HO (C867-1) x Y769	12726	39.30	16.19	146	85.2
Y869H46	7869-6HO x Y769	12556	39.70	15.80	148	83.7
Topcrosses to mm populations						
Y869H17	7817HO (C790-7) x Y769	12565	40.05	15.65	155	85.1
Y869H18	7818HO (C790-8) x Y769	12681	40.25	15.71	156	86.0
Y869H49	7848H88mm x Y769	12312	39.80	15.50	156	84.3
Y869H35	7835mmaa x Y769	12330	39.03	15.75	144	83.5
Y869H38	7838mmaa x Y769	12428	40.95	15.16	148	84.5
Y869H55	7835H50 x Y769	12239	39.45	15.49	143	84.5
Y869H58	7838H50 x Y769	12196	38.80	15.65	158	83.8
Y869H69	7869aa x Y769	12988	40.70	15.95	161	83.9
Y869H88	7890HO (C890-1) x Y769	12140	39.60	15.29	149	83.1

TEST 2799. EVALUATION OF TOPCROSS HYBRIDS, SALINAS, CA., 1999

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	RJAP %
Topcrosses to mm populations (cont.)						
Y869H30M	7932CTMaa x Y769	12733	39.50	16.13	147	83.6
Y869H31	7931aa x Y769	12819	40.55	15.81	145	83.4
C831-4 topcrossed						
R882H27	6831-4HO (C831-4) x R781,R776	13141	41.80	15.70	150	83.2
Y875H27	6831-4HO (C831-4) x Y775	12918	41.45	15.59	147	82.1
Mean		12862.6	40.17	16.00	147.7	83.9
LSD (.05)		1253.2	3.06	1.39	14.8	2.1
C.V. (%)		9.9	7.73	4.94	10.2	2.5
F value		1.8*	1.03NS	6.20**	4.8**	1.8*

TEST 2399. HYBRID PERFORMANCE OF MONOGERM S_1 PROGENY LINES, 1999

72 entries x 4 reps., RCB
1-row plots, 21 ft. long

Planted: March 24, 1999
Harvested: September 27, 1999

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	RJAP
		Lbs	Tons	%	No.	%
Checks						
Rifle	Spreckels, 9-98, L1162401	13365	38.40	17.44	155	84.4
B4776R	Beta 4776R.7653 (3-27-98)	15419	42.90	17.98	169	85.2
Y869H50	C790-15CMS x Y769	14788	44.90	16.49	173	84.8
Y869H46	7869-6HO x Y769	14548	43.40	16.81	158	83.9
S_1 lines from popn-833						
Y869H35	7835aa xY769	13681	41.40	16.50	161	83.2
Y869H5	5833-5aa (C833-5) x Y769	13336	38.80	17.25	161	82.4
Y869H33-1	7833-1aa x Y769	11503	35.60	16.19	164	83.1
Y869H33-3	7833-3aa x Y769	12757	38.00	16.76	156	83.1
Y869H33-10	7833-10aa x Y769	14527	43.53	16.69	155	83.9
Y869H33-11	7833-11aa x Y769	14224	44.00	16.16	163	83.0
Y869H33-12	7833-12aa x Y769	12707	39.80	15.94	145	83.6
Y869H12	5833-12aa (C833-12) x Y769	11976	36.80	16.25	93	84.5
S_1 lines from popn-834						
Y869H29	5829-3aa (C829-3) x Y769	12541	38.53	16.25	145	83.2
Y869H34-1	7834-1aa x Y769	12710	38.50	16.49	156	83.5
Y869H34-2	7834-2aa x Y769	12789	38.40	16.65	158	82.9
Y869H34-3	7834-3aa x Y769	13397	40.10	16.71	149	81.8
Y869H34-5	7834-5aa x Y769	13489	42.70	15.76	154	84.0
Y869H34-8	7834-8aa x Y769	13107	40.80	16.09	156	84.7
S_1 lines from popn-828						
Y869H28-9	7828-9aa x Y769	13242	42.80	15.48	159	83.8
Y869H28-10	7828-10aa x Y769	13665	42.80	16.01	168	84.7

TEST 2399. HYBRID PERFORMANCE OF MONOGERM S_1 PROGENY LINES, 1999

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	RJAP %
S_1 lines from popn-869						
Y869H69	7869aa x Y769	13219	41.20	16.06	144	84.3
Y869H69- 1	7869- 1aa x Y769	13448	41.50	16.21	146	82.8
Y869H69- 2	7869- 2aa x Y769	13923	43.78	15.90	154	84.0
Y869H69- 4	7869- 4aa x Y769	12530	37.50	16.71	148	82.3
Y869H69- 5	7869- 5aa x Y769	12721	40.40	15.76	131	84.3
Y869H69- 6	7869- 6aa x Y769	12834	39.10	16.44	157	83.4
Y869H69- 7	7869- 7aa x Y769	13278	39.50	16.81	152	83.0
Y869H69-13	7869-13aa x Y769	14662	44.70	16.41	150	84.2
Y869H69-19	7869-19aa x Y769	13928	43.40	16.00	156	85.9
Y869H69-20	7869-20aa x Y769	13688	41.40	16.56	162	84.0
Y869H69-20B	7869-20Baa x Y769	13485	41.90	16.14	152	79.7
Y869H69-24	7869-24aa x Y769	12780	38.50	16.61	164	84.6
S_1 lines from popn-836						
Y869H38	7838aa x Y769	12862	40.84	15.71	146	83.5
Y869H36- 3	7836- 3aa x Y769	12829	39.30	16.21	133	82.2
Y869H36-11	7836-11aa x Y769	13477	41.20	16.33	134	82.7
Y869H36-14	7836-14aa x Y769	12558	38.20	16.45	133	83.8
S_1 lines from popn-837						
Y869H77-1	7837-1aa x Y769	13222	40.56	16.31	120	83.2
Y869H77-1B	7837-1Baa x Y769	13012	40.00	16.29	140	82.8
Y869H77-2	7837-2aa x Y769	13599	41.80	16.25	156	81.2
Y869H77-3	7837-3aa x Y767	13713	42.40	16.16	159	83.1
Y869H77-4	7837-4aa x Y769	12143	37.90	16.01	144	83.7

TEST 2399. HYBRID PERFORMANCE OF MONOGERM S_1 PROGENY LINES, 1999

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	RJAP %
S_1 lines from popn-839						
Y869H79-1	7839-1aa x Y769	12545	38.90	16.11	168	83.3
Y869H79-2	7839-2aa x Y769	12537	40.80	15.41	145	83.6
Y869H79-3	7839-3aa x Y769	13459	41.10	16.38	162	84.6
Y869H79-4	7839-4aa x Y769	11858	36.00	16.47	163	83.4
Y869H79-5	7839-5aa x Y769	13819	42.30	16.31	151	83.4
Y869H79-5B	7839-5Baa x Y769	13888	41.70	16.65	145	83.7
Y869H79-6	7839-6aa x Y769	13242	40.40	16.40	157	84.9
Y869H79-10	7839-10aa x Y769	13886	44.00	15.80	154	82.8
S_1 lines from popn-831-4						
Y869H4	5831-3aa (C831-3) x Y769	13614	41.55	16.39	118	83.6
Y869H27-1	7831-4-1aa x Y769	13113	39.98	16.38	123	82.9
Y869H27-2	7831-4-2aa x Y769	13739	42.68	16.14	129	82.1
Y869H27-7	7831-4-7aa x Y769	14040	42.90	16.39	161	81.8
Y869H27-8	7831-4-8aa x Y769	13328	41.20	16.19	138	83.4
Y869H27-9	7831-4-9aa x Y769	12640	38.40	16.51	113	81.1
Y869H27-10	7831-4-10aa x Y769	13953	43.10	16.25	140	81.8
S_1 lines from popn-808						
Y869H9-1	7808-1aa x Y769	13826	42.80	16.14	148	84.2
Y869H9-2	7808-2aa x Y769	13911	41.70	16.67	143	83.6
Y869H9-3	7808-3aa x Y769	13697	40.70	16.81	132	82.2
Y869H9-4	7808-4aa x Y769	12914	40.20	16.09	154	84.1
Y869H9-7	7808-7aa x Y769	13890	43.97	15.81	137	83.0
Y869H9-8	7808-8aa x Y769	13002	40.78	15.90	125	84.4
Y869H9-9	7808-9aa x Y769	12542	38.10	16.46	137	84.3
Y869H9-12	7808-12aa x Y769	12633	41.60	15.21	145	83.1

TEST 2399. HYBRID PERFORMANCE OF MONOGERM S_1 PROGENY LINES, 1999

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	RJAP %
S_1 lines from popn-808 (cont.)						
Y869H9-13	7808-13aa x Y769	13270	41.50	16.02	146	83.4
Y869H9-16	7808-16aa x Y769	12132	38.50	15.76	125	85.1
S_1 lines from popn-818						
Y869H15-1B	6818-1Baa x Y769	13119	39.50	16.66	158	83.0
Y869H15-2B	6818-2Baa x Y769	13648	42.20	16.21	145	82.3
Y869H15-1	6818-1aa x Y769	13361	40.78	16.41	144	83.0
Y869H15-2	6818-2aa x Y769	12745	39.90	15.96	157	82.4
Y869H15-6	6818-6aa x Y769	13384	42.00	15.96	163	80.3
Y869H15-21	6818-21aa x Y769	12687	39.70	15.97	134	83.4
Mean		13279.1	40.78	16.29	147.8	83.3
LSD (.05)		1899.2	5.51	0.71	15.9	2.3
C.V. (%)		10.3	9.70	3.13	7.7	2.0
F value		1.1NS	1.11NS	2.89**	6.6**	1.8**

Notes: Monogerm, self-fertile, genetic-male-sterile facilitated random-mated populations that segregate for resistance to rhizomania, O-type, etc. have been developed. From these, rhizomania resistant (*Rz_*) S_o plants were selected, selfed to produce S_1 progeny lines, and crossed to an annual, male-sterile, type-O tester. Selected S_1 progeny were topcrossed to C69 using genetic male steriles to produce topcross hybrids for evaluating early generation general combining ability for components of sugar yield. Test 2399 serves as a screening trial to determine if any of these S_1 lines are worth further breeding effort. Also, these hybrids are used to evaluate the potential value of these source populations for future breeding efforts and population improvement.

TEST 5499. PERFORMANCE OF EXPERIMENTAL HYBRIDS, SALINAS, CA., 1999

48 entries x 8 reps., RCB(e) — Planted: April 29, 1999
1-row plots, 22 ft. long — Harvested: November 2, 1999

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Root Rot %	RJAP %
5499-1: Testcross hybrids							
KW6770	Susc. check, 6770.5193,1-10-97	5393	16.12	16.56	164	28.5	86.2
Rifle	Spreckels, 2-8-99	7483	20.86	17.91	163	43.2	85.2
R876-89-5NBH50	C790-15CMS x RZM-%S R576-89-5NB	7785	22.21	17.50	178	36.3	85.2
US H11	susceptible check	4188	14.52	14.27	153	36.3	85.1
R882H50	C790-15CMS x R781, R776 (C82)	8004	24.51	16.38	172	30.7	86.1
Y869H50	C790-15CMS x Y769 (C69)	6451	19.34	16.65	173	31.1	86.6
Y868H50	C790-15CMS x RZM Y768	5355	16.56	16.10	185	35.0	86.1
R878H50 (Iso)	C790-15CMS x RZM R778% (C78)	6729	19.84	16.90	174	38.8	87.2
Y866H50	C790-15CMS x RZM Y766	7716	22.77	16.92	181	29.5	85.7
Y867H50	C790-15CMS x RZM Y767 (C67)	6461	19.52	16.51	178	40.0	85.5
Y871H50	C790-15CMS x RZM Y771	9271	27.71	16.70	182	33.6	85.4
Y872H50	C790-15CMS x RZM-%S Y672 (C72)	9222	27.26	16.90	181	33.5	86.1
Y872BH50	C790-15CMS x RZM Y772 (C72)	8674	25.48	17.01	184	23.3	85.3
Y875H50 (Iso)	C790-15CMS x RZM Y775	6884	20.66	16.63	180	38.2	85.7
Y873BH50	C790-15CMS x RZM Y773	6871	21.08	16.26	178	31.6	87.2
R854H50	C790-15CMS x RZM R754	5671	17.52	16.21	169	25.8	84.2
Mean		7009.9	21.00	16.59	174.6	33.5	85.8
LSD (.05)		1240.4	3.69	0.53	17.9	12.9	2.2
C.V. (%)		17.9	17.76	3.21	10.3	39.1	2.5
F value		10.5**	8.64**	16.88**	1.9NS	1.3NS	1.0NS

TEST 5499. PERFORMANCE OF EXPERIMENTAL HYBRIDS, SALINAS, CA., 1999
48 entries x 8 reps., RCB(e). ANOVA to compare means across sets of entries.

	Sugar Lbs	Beets Tons	Sucrose %	Beets/100' No.	Root Rot %	RJAP %
Mean	7612.1	22.70	16.72	176.9	29.8	85.9
LSD (.05)	1318.5	3.79	0.59	8.2	13.3	2.2
C.V. (%)	17.6	16.94	5.98	4.7	45.2	2.6
F value	6.2**	5.72**	6.68**	11.0**	2.0**	1.2NS

TEST 5499. PERFORMANCE OF EXPERIMENTAL HYBRIDS, SALINAS, CA., 1999

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Root Rot %	RJAP %
5499-2: Population hybrids							
B4776R	Betaseed, 1-19-99	9703	27.40	17.70	190	14.1	87.0
SS-432R	Spreckels, 2-8-99	6962	20.46	17.06	159	24.1	84.6
8913-70H50	C790-15CMS x RZM-ER-% 5913-70	7991	23.77	16.77	185	35.5	86.3
R882H38	7838mmaa x R781, R776 (C82)	8279	24.87	16.65	161	26.2	86.8
8931H50	C790-15CMS x RZM 7931	7730	22.61	17.04	181	31.8	85.4
8924H50	C790-15CMS x RZM 7924	6863	20.78	16.54	179	32.3	86.2
8932H50	C790-15CMS x 7932CT, …	6106	18.88	16.26	181	31.8	86.1
Z831H50	C790-15CMS x RZM Z730, Z731	7231	21.65	16.64	178	34.9	86.5
8926H50 (Sp)	C790-15CMS x RZM 7926	7351	22.17	16.48	180	34.1	85.2
8935H50 (Iso)	C790-15CMS x RZM R776-89-5H13	8011	23.20	17.26	181	31.8	86.0
8936H50	C790-15CMS x RZM R776-89-5H31	8224	23.92	17.23	173	31.3	83.9
8937H50	C790-15CMS x RZM R776-89-5H11	8080	23.67	17.06	188	29.4	86.8
8938H50	C790-15CMS x RZM Z731H11	6446	18.80	17.17	175	49.1	85.8
8939H50	C790-15CMS x RZM Y769H31	7519	22.50	16.45	181	27.1	84.0
CR812H50	C790-15CMS x RZM CR712	6471	19.30	16.74	195	39.9	86.8
CR813H50	C790-15CMS x RZM CR713	8198	24.93	16.45	176	33.2	86.0
Mean		7572.8	22.43	16.84	178.9	31.7	85.8
LSD (.05)		1331.0	3.72	0.68	15.5	12.1	2.2
C.V. (%)		17.8	16.76	4.09	8.8	38.5	2.5
F value		3.6**	3.24**	2.55**	2.8*	3.0**	1.6NS

TEST 5499. PERFORMANCE OF EXPERIMENTAL HYBRIDS, SALINAS, CA., 1999

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Root Rot %	RJAP %
5499-3: Topcross hybrids							
B4035R	Betaseed, 7-10-97	9125	27.26	16.73	196	16.9	86.9
B4419R	Betaseed, 1-19-99	6511	18.69	17.42	182	23.8	86.8
8931H38	7838mmaa x RZM 7931	8347	25.18	16.56	165	23.6	85.2
8935H38	7838mmaa x R776-89-5H13	7432	22.29	16.65	175	27.4	86.3
Y869H38	7838mmaa x Y769	8422	25.56	16.48	166	23.7	87.1
Y869H35	7835aa x Y769	7485	22.69	16.46	183	26.1	85.0
Y869H69	7869aa x Y769	7750	23.33	16.69	182	25.6	85.8
Y869H46	7869-6HO x Y769	8209	24.53	16.73	177	25.6	86.1
Y875H55	7835H50 x Y775	8143	24.52	16.61	176	30.2	84.9
8931H46	7869-6HO x RZM 7931	7771	23.55	16.49	181	22.9	85.4
Y875H27	6831-4HO x Y775	9195	27.32	16.81	170	27.3	85.9
Y869H27	6831-4HO x Y769	8379	25.63	16.34	175	24.7	85.1
B4430R	Betaseed	9840	27.54	17.88	205	21.8	87.8
Y869H45	7867-1HO x Y769	8171	24.88	16.45	173	19.4	85.8
Y869H7	6911-4-7HO x Y769	8362	24.77	16.89	159	23.5	85.0
R882H27	6831-4HO x R781, R776	8912	26.73	16.64	171	25.1	86.3
Mean		8253.5	24.66	16.74	177.2	24.2	86.0
LSD (.05)		988.6	2.74	0.56	15.5	11.1	2.2
C.V. (%)		12.1	11.23	3.37	8.8	46.5	2.6
F value		5.1**	5.34**	3.88**	4.2**	0.6NS	1.2NS

Notes: Root rot due to *Sclerotium rolfsii*. Roots with obvious rot counted before harvest. Rotted roots weighed at harvest but not included in sugar sample. Root rot caused considerable variability in plot weights.

TEST 5899. EVALUATION OF TESTCROSS HYBRIDS, SALINAS, CA., 1999

48 entries x 4 reps., RCB
1-row plots, 22 ft. long

Planted: April 29, 1999
Harvested: November 1, 1999

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Root Rot %	RJAP %
Experimental hybrids with S_1 pollinators							
US H11	Susc. check	6054	20.23	15.02	155	23.2	85.7
Rifle	Spreckels, 2-98, L1162401	8501	23.16	18.40	168	25.3	85.9
B4776R	Betaseed 4776R.7653 (3-27-98)	10973	30.07	18.25	190	10.2	87.8
8931H50	C790-15CMS x RZM 7931	8323	25.30	16.45	186	24.7	82.7
8925-19H50	C790-15CMS x 6925-19	10653	30.07	17.70	186	26.7	87.0
8913-70H50	C790-15CMS x RZM-ER-%S 6913-70	9685	27.51	17.63	185	10.7	85.2
8911-4-10H50	C790-15CMS x RZM-ER-%S 6911-4-10	10118	28.00	18.08	175	25.7	83.7
8918-12H50	C790-15CMS x RZM-ER-%S 6918-12	9651	27.01	17.83	177	30.8	88.1
8918-21H50	C790-15CMS x RZM 7918-21	7672	22.55	17.00	155	47.0	86.8
Z825-6H50	C790-15CMS x Z625-6	8299	23.63	17.50	165	32.8	87.0
Z825-9H50	C790-15CMS x Z625-9	10250	28.33	18.10	183	32.0	83.7
Z830-11H50	C790-15CMS x Z630-11	8023	24.19	16.50	178	22.9	85.1
R709-1H50	C790-15CMS x CR-RZM R509A-1	9039	25.83	17.48	170	21.4	84.2
CR812H50	C790-15CMS x RZM CR712	7163	20.62	17.40	177	37.0	84.0
CR813H50	C790-15CMS x RZM CR713	8613	25.89	16.65	180	26.3	85.4
R709-9H50	C790-15CMS x CR-RZM R509A-9	8379	26.28	15.93	178	35.4	85.1
S_1 pollinators from MM , VY, S^f, Aa,*Rz* popns							
R878H50 (Sp)	C790-15CMS x R778, R778%	7906	22.80	17.30	170	35.1	86.5
8930-19H50	C790-15CMS x 6930-19	8103	23.31	17.35	169	34.9	85.9
8930-39H50	C790-15CMS x 6930-39	7617	22.15	17.08	186	32.7	84.9
8930-102H50	C790-15CMS x 6930-102	7884	22.11	17.83	191	33.1	85.0
R882H50	C790-15CMS x R781,R776	8790	26.32	16.65	176	19.0	85.7
SS-432R	Spreckels	7983	22.64	17.73	172	13.2	84.1

TEST 5899. EVALUATION OF TESTCROSS HYBRIDS, SALINAS, CA., 1999

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Root Rot %	RJAP %
S_1 pollinators from MM , VY, S^f, Aa,Rz popns (cont.)							
8929-41H50	C790-15CMS x 6929-41	9948	29.07	17.13	181	11.1	85.0
8929-72H50	C790-15CMS x 6929-72	6260	18.73	16.88	161	39.1	85.4
8929-102H50	C790-15CMS x 6929-102	8914	25.65	17.38	183	16.1	85.5
8929-112H50	C790-15CMS x 6929-112	10463	29.79	17.55	173	26.5	86.3
8929-114H50	C790-15CMS x 6929-114	11174	31.25	17.88	191	13.1	86.6
8929-115H50	C790-15CMS x 6929-115	8811	25.17	17.48	187	22.5	83.8
8929-133H50	C790-15CMS x 6929-133	9376	27.21	17.23	181	20.1	85.7
8929-153H50	C790-15CMS x 6929-153	7712	22.23	17.33	178	24.0	85.7
8929-154H50	C790-15CMS x 6929-154	9209	26.19	17.58	192	20.1	83.6
8924H50	C790-15CMS x RZM 7924	7335	21.75	16.75	187	25.1	86.7
S_1 pollinators from MM, S^f, Aa, R22 popns							
4035R	Betaseed, 7-10-97	9144	26.06	17.55	197	14.7	85.8
Rizor	Holly HH108, 9-3-97	9416	26.07	18.05	198	15.5	85.4
Y869H50	C790-15CMS x Y769	9054	26.82	16.90	174	17.6	85.1
R835H50	C790-15CMS x RZM R735 (C79-7)	8663	25.55	16.95	182	18.8	85.2
R836H50	C790-15CMS x RZM R736,R746(C79-8)	8834	26.26	16.83	182	15.6	85.4
Y873BH50	C790-15CMS x RZM Y773	7960	24.14	16.50	186	28.9	86.7
R879H50	C790-15CMS x RZM R779 (C79-1)	7003	23.19	15.13	185	35.2	86.5
Y867H50	C790-15CMS x RZM Y767 (C67)	7366	22.14	16.70	181	35.1	85.0
Y872H50	C790-15CMS x RZM-%S Y672	10374	31.51	16.45	176	15.8	84.7
875H50	C790-15CMS x RZM Y775, …	8442	25.22	16.77	184	23.3	86.5
8926H50 (Sp)	C790-15CMS x RZM 7926, …	8367	25.48	16.40	192	20.5	84.6
8926H50 (Iso)	C790-15CMS x RZM 7926	8705	26.15	16.65	184	16.8	83.4

TEST 5899. EVALUATION OF TESTCROSS HYBRIDS, SALINAS, CA., 1999

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Root Rot %	RJAP %
S_1 pollinators from MM, S^f, Aa, R22 popns (cont.)							
8927-29H50	C790-15CMS x 6927-29	8768	24.06	18.23	165	29.0	85.4
8927-30H50	C790-15CMS x 6927-30	8156	23.82	17.03	178	21.8	85.3
8927-33H50	C790-15CMS x 6927-33	9042	25.37	17.80	181	26.4	85.3
8927-37H50	C790-15CMS x 6927-37	8628	25.65	16.92	165	24.4	85.9
Mean		8683.4	25.26	17.16	179.1	24.5	85.4
LSD (.05)		1938.5	5.18	0.77	26.9	19.5	2.5
C.V. (%)		16.0	15.52	3.19	10.7	57.0	2.1
F value		2.7**	2.08**	6.91**	1.1NS	1.4NS	1.6*

Notes: Root rot due to *Sclerotium rolfsii*. Roots with obvious rot counted before harvest. Rotted roots weighed at harvest but not included in sugar sample. Root rot caused considerable variability in plot weights.

TEST 5699. EVALUATION OF TOPCROSS HYBRIDS, SALINAS, CA., 1999

24 entries x 4 reps., RCB
1-row plots, 22 ft. long

Planted: April 29, 1999
Harvested: November 3, 1999

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Root Rot %	RJAP %
Checks							
B4776R	Betaseed 4776.7653, 3-27-98	9970	27.69	18.00	187	11.2	84.9
Rifle	Spreckels, 9-16-98	7116	19.70	18.08	187	28.1	86.3
Topcrosses to released mm lines							
Y869H50	C790-15CMS x Y769	7368	22.07	16.70	193	26.6	84.8
US H11	susc. ck.	4468	14.67	15.18	175	37.5	87.2
Y869H37	4807HO (C306/2CMS) x Y769	6851	21.35	16.05	194	23.2	85.4
Y869H7	6911-4-7HO (C911-4-7) x Y769	7523	22.47	16.73	170	23.2	84.0
R678H33-5	5833-5aa (C833-5) x R578	8149	23.05	17.65	170	19.6	84.6
Y869H27	6831-4HO (C831-4) x Y769	8424	24.82	17.00	164	20.8	87.7
B4430R	Betaseed	9583	26.26	18.25	185	5.9	87.3
Y869H45	7867-1HO (C867-1) x Y769	7154	21.40	16.70	180	22.3	86.2
Y869H46	7869-6HO x Y769	8500	24.92	17.05	178	18.9	86.9
Topcrosses to mm populations							
Y869H17	7817HO (C790-7) x Y769	7339	22.45	16.33	173	30.5	84.2
Y869H18	7818HO (C790-8) x Y769	7601	22.71	16.73	187	24.7	86.1
Y869H49	7848H88mm x Y769	7403	22.23	16.65	176	30.1	86.3
Y869H35	7835mmaa x Y769	8300	24.25	17.10	178	13.5	86.2
Y869H38	7838mmaa x Y769	8159	23.87	17.10	162	19.1	86.0
Y869H55	7835H50 x Y769	8410	24.35	17.27	180	23.8	86.2
Y869H58	7838H50 x Y769	7565	22.21	17.02	186	19.2	85.9
Y869H69	7869aa x Y769	8859	25.87	17.10	189	10.8	86.6
Y869H88	7890HO (C890-1) x Y769	7757	23.24	16.75	180	30.1	84.5

TEST 5699. EVALUATION OF TOPCROSS HYBRIDS, SALINAS, CA., 1999

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Root Rot %	RJAP %
Topcrosses to mm populations (cont.)							
Y869H30M	7932CTMaa x Y769	8591	25.01	17.15	151	26.2	84.0
Y869H31	7931aa x Y769	8783	26.26	16.73	173	17.9	83.4
C831-4 topcrossed							
R882H27	6831-4HO (C831-4) x R781,R776	9066	27.21	16.63	161	16.0	85.6
Y875H27	6831-4HO (C831-4) x Y775	8167	24.82	16.45	181	14.9	84.2
Mean		7962.8	23.45	16.93	177.6	21.4	85.6
LSD (.05)		1178.0	3.18	0.79	23.5	15.2	2.7
C.V. (%)		10.5	9.61	3.31	9.4	50.3	2.3
F value		6.8**	5.86**	5.48**	1.7NS	1.9*	1.5NS

Notes: Root rot due to *Sclerotium rolfsii*. Roots with obvious rot counted before harvest. Rotted roots weighed at harvest but not included in sugar sample. Root rot caused considerable variability in plot weights.

TEST 5599. HYBRID PERFORMANCE OF MONOGERM S_1 PROGENY LINES, SALINAS, CA., 1999

72 entries x 4 reps., RCB
1-row plots, 12 ft. long

Planted: April 29, 1999
Harvested: November 3, 1999

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Root Rot	RJAP
		Lbs	Tons	%	No.	%	%
Checks							
Rifle	Spreckels, 9-98, L1162401	8093	22.43	18.02	186	35.6	85.9
B4776R	Beta 4776R.7653 (3-27-98)	9847	28.44	17.30	190	10.2	87.0
Y869H50	C790-15CMS x Y769	6663	20.86	15.70	176	36.2	84.4
Y869H46	7869-6HO x Y769	6634	19.77	16.88	175	33.0	86.0
S_1 lines from popn-833							
Y869H35	7835aa xY769	7963	23.31	17.13	167	26.3	87.0
Y869H5	5833-5aa (C833-5) x Y769	9227	26.01	17.73	158	15.2	85.5
Y869H33-1	7833-1aa x Y769	6091	18.37	16.58	177	26.9	86.6
Y869H33-3	7833-3aa x Y769	8298	23.68	17.53	185	12.5	86.5
Y869H33-10	7833-10aa x Y769	7001	19.98	17.50	189	36.4	85.4
Y869H33-11	7833-11aa x Y769	6528	19.20	17.02	183	49.0	86.6
Y869H33-12	7833-12aa x Y769	8374	24.44	17.13	153	28.9	85.4
US H11	susc. check	5221	17.96	14.50	175	26.3	86.3
S_1 lines from popn-834							
B4035R	Betaseed, 7-10-97	7415	22.19	16.75	186	21.8	85.5
Y869H34-1	7834-1aa x Y769	6977	20.88	16.67	189	22.5	86.2
Y869H34-2	7834-2aa x Y769	6424	18.53	17.25	159	14.9	84.5
Y869H34-3	7834-3aa x Y769	7429	21.48	17.28	168	20.1	83.7
Y869H34-5	7834-5aa x Y769	6707	20.27	16.55	181	35.5	86.1
Y869H34-8	7834-8aa x Y769	7307	21.48	16.98	190	17.5	85.6
S_1 lines from popn-828							
Y869H28-9	7828-9aa x Y769	6853	22.26	15.38	185	38.0	86.7
Y869H28-10	7828-10aa x Y769	5366	16.95	15.85	183	25.8	87.5

TEST 5599. HYBRID PERFORMANCE OF MONOGERM S_1 PROGENY LINES, SALINAS, CA., 1999

(cont.)

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Root Rot	RJAP
		Lbs	Tons	%	No.	%	%
S_1 lines from popn-869							
Y869H69	7869aa x Y769	7535	22.26	16.92	198	22.5	85.2
Y869H69- 1	7869- 1aa x Y769	8820	26.01	17.00	173	35.0	86.7
Y869H69- 2	7869- 2aa x Y769	7510	21.80	17.22	182	26.3	85.3
Y869H69- 4	7869- 4aa x Y769	6734	20.16	16.70	185	29.6	85.0
Y869H69- 5	7869- 5aa x Y769	8037	23.91	16.80	155	23.7	88.1
Y869H69- 6	7869- 6aa x Y769	7498	22.91	16.38	174	11.5	84.7
Y869H69- 7	7869- 7aa x Y769	7870	22.76	17.30	170	18.2	86.0
Y869H69-13	7869-13aa x Y769	8112	24.00	16.92	184	16.7	85.2
Y869H69-19	7869-19aa x Y769	6647	20.56	16.15	187	22.5	85.6
Y869H69-20	7869-20aa x Y769	7757	22.91	17.00	177	17.6	84.4
Y869H69-20B	7869-20Baa x Y769	8051	24.06	16.73	162	40.5	85.2
Y869H69-24	7869-24aa x Y769	5447	15.58	17.40	185	28.1	86.5
S_1 lines from popn-836							
Y869H38	7838aa x Y769	7895	24.48	16.13	172	33.5	85.2
Y869H36- 3	7836- 3aa x Y769	7800	23.20	16.80	131	22.8	85.6
Y869H36-11	7836-11aa x Y769	8818	25.94	16.97	144	16.9	87.1
Y869H36-14	7836-14aa x Y769	8882	25.74	17.27	131	11.9	86.2
S_1 lines from popn-837							
Y869H77-1	7837-1aa x Y769	8577	25.01	17.13	134	21.2	86.0
Y869H77-1B	7837-1Baa x Y769	7975	23.84	16.75	148	27.8	86.8
Y869H77-2	7837-2aa x Y769	7511	22.53	16.67	174	19.8	83.8
Y869H77-3	7837-3aa x Y767	6990	20.66	16.90	190	35.6	85.3
Y869H77-4	7837-4aa x Y769	8317	25.89	16.08	153	27.0	84.6

TEST 5599. HYBRID PERFORMANCE OF MONOGERM S_1 PROGENY LINES, SALINAS, CA., 1999

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Root Rot %	RJAP %
S_1 lines from popn-839							
Y869H79-1	7839-1aa x Y769	7633	23.00	16.63	187	21.4	83.8
Y869H79-2	7839-2aa x Y769	7211	22.15	16.30	178	35.1	86.9
Y869H79-3	7839-3aa x Y769	7777	22.94	16.95	199	31.4	86.5
Y869H79-4	7839-4aa x Y769	6943	21.07	16.48	186	31.8	85.4
Y869H79-5	7839-5aa x Y769	8112	23.87	17.02	168	23.8	87.3
Y869H79-5B	7839-5Baa x Y769	8150	24.15	16.90	166	14.0	86.4
Y869H79-6	7839-6aa x Y769	6812	20.55	16.58	170	50.1	86.1
Y869H79-10	7839-10aa x Y769	7913	24.69	16.02	153	16.3	86.2
S_1 lines from popn-831-4							
Y869H27	6831-4HO (C831-4)	8529	25.62	16.63	167	14.9	85.8
Y869H27-1	7831-4-1aa x Y769	8481	24.34	17.42	119	21.8	84.8
Y869H27-2	7831-4-2aa x Y769	8136	23.72	17.15	136	18.3	87.0
Y869H27-7	7831-4-7aa x Y769	9879	28.45	17.40	178	22.6	84.4
Y869H27-8	7831-4-8aa x Y769	9505	27.60	17.20	168	27.7	86.7
Y869H27-9	7831-4-9aa x Y769	9796	27.51	17.80	141	18.3	82.6
Y869H27-10	7831-4-10aa x Y769	10574	29.88	17.70	169	24.2	85.5
S_1 lines from popn-808							
Y869H9-1	7808-1aa x Y769	8394	24.63	17.00	175	27.8	86.7
Y869H9-2	7808-2aa x Y769	7065	20.75	17.00	189	47.4	87.6
Y869H9-3	7808-3aa x Y769	6945	20.83	16.63	167	30.4	84.8
Y869H9-4	7808-4aa x Y769	8007	23.19	17.25	167	26.2	87.0
Y869H9-7	7808-7aa x Y769	7855	23.68	16.60	156	19.5	85.6
Y869H9-8	7808-8aa x Y769	7123	22.05	16.17	164	19.4	87.2
Y869H9-9	7808-9aa x Y769	7388	22.53	16.38	165	11.0	86.1
Y869H9-12	7808-12aa x Y769	7438	23.65	15.73	178	23.0	86.5

TEST 5599. HYBRID PERFORMANCE OF MONOGERM S_1 PROGENY LINES, SALINAS, CA., 1999

(cont.)

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Root Rot	RJAP
		Lbs	Tons	%	No.	%	%
S_1 lines from popn-808 (cont.)							
Y869H9-13	7808-13aa x Y769	8208	23.68	17.33	168	30.2	87.1
Y869H9-16	7808-16aa x Y769	7038	22.44	15.65	135	37.9	86.5
S_1 lines from popn-818							
Y869H15-1B	6818-1Baa x Y769	7552	22.25	17.00	168	25.8	86.2
Y869H15-2B	6818-2Baa x Y769	8407	24.76	16.95	170	33.5	84.5
Y869H15-1	6818-1aa x Y769	7803	23.14	16.85	161	24.5	84.1
Y869H15-2	6818-2aa x Y769	7794	23.19	16.80	176	35.2	83.7
Y869H15-6	6818-6aa x Y769	7474	22.76	16.40	180	22.6	84.3
Y869H15-21	6818-21aa x Y769	8174	24.22	16.88	136	34.8	85.1
Mean		7712.7	22.92	16.80	169.6	25.9	85.8
LSD (.05)		1407.0	3.99	0.77	26.5	19.0	2.5
C.V. (%)		13.1	12.49	3.29	11.2	52.7	2.1
F value		4.0**	3.33**	4.56**	3.4**	1.7**	1.5*

Notes: Root rot due to *Sclerotium rolfsii*. Roots with obvious rot counted before harvest. Rotted roots weighed at harvest but not included in sugar sample. Root rot caused considerable variability in plot weights.

TEST 5099. WESTERN SUGAR, BETASEED, & USDA HYBRID EVALUATION UNDER RHIZOMANIA, SALINAS, CA., 1999

48 entries x 7 reps., RCB
1-row plots, 22 ft. long

Planted: April 29, 1999
Not harvested for yield
Scored: October 12-13, 1999

Variety	Description	Stand Count Mean	Harv. Count Mean	Survival %	Missing Feet Mean	No. Rot Mean	Root Rot (Stand) %	Rhizomania Resistance DI	Rhizomania Resistance %R(0-4)
Western Sugar entries									
Rizor	rec'd 4-9-99	39.9	38.0	95.2	0.4	1.9	4.7	3.2	89.1
Crystal 9906		40.6	39.0	96.7	0.0	1.3	3.4	2.7	96.8
HM 1646		40.1	23.7	59.7	4.6	8.0	19.9	3.2	90.3
Crystal 923R		42.3	33.4	78.8	1.6	6.4	15.5	3.2	94.0
Rifle		37.4	29.0	77.5	2.3	7.1	19.2	3.4	84.6
Beta A943R		40.7	41.0	100.0	0.3	1.6	3.7	3.2	93.1
HM 1693		38.7	33.9	88.1	1.4	4.7	12.1	2.9	98.7
Crystal 924R		42.3	41.0	97.3	0.0	1.0	2.2	3.0	96.5
Beta 4006R		37.9	36.1	95.5	0.6	0.7	2.0	3.2	87.3
HM 1645		38.4	31.6	83.5	2.4	7.0	17.6	3.6	80.0
Beta 4038R		41.3	35.6	86.2	1.4	5.0	12.2	2.9	96.7
HM 1647		40.1	38.6	96.0	0.0	0.6	1.4	3.3	89.2
Beta A940R		37.1	33.6	90.3	0.9	2.4	6.8	3.6	77.6
Beta A942R		40.9	30.3	73.7	2.6	8.7	21.7	3.5	82.9
SX Kojak		40.6	28.4	71.1	2.6	7.1	17.0	3.6	74.2
Monohikari		38.9	25.4	65.3	4.3	9.9	25.0	4.8	30.4
Western Sugar entries (Transgenics)									
Beta 4546LL		45.1	33.3	73.9	1.6	5.3	11.8	5.6	9.1
Beta A893LL	rec'd 4-9-99	42.1	24.4	58.0	4.0	9.9	23.5	5.4	11.2
7CG9236LL		46.4	36.3	78.7	1.1	6.9	14.5	3.1	97.0
HM 1605RR		38.1	26.3	68.7	3.3	7.7	20.5	5.2	18.4
HM RH3RR		31.7	30.9	97.3	1.6	0.9	3.0	4.2	46.6
HM 106RR		41.3	35.4	85.7	1.3	3.7	9.0	4.0	53.1
HM 1628RR		36.4	23.7	65.5	3.0	5.3	14.6	5.1	20.0
Crystal 978LL		44.1	32.3	72.9	2.6	8.6	19.8	5.0	28.3
SX0220LL		38.9	20.1	50.1	7.3	10.0	26.0	5.7	3.1

TEST 5099. WESTERN SUGAR, BETASEED, & USDA HYBRID EVALUATION UNDER RHIZOMANIA, SALINAS, CA., 1999

(cont.)

Variety	Description	Stand Count	Harv. Count	Survi-val	Missing Feet	No. Rot	Root Rot (Stand)	Rhizomania Resistance	
		Mean	Mean	%	Mean	Mean	%	DI	%R(0-4)
Checks for transgenics									
Monohikari	Seedex, 4-16-99, susc. ck.	39.6	21.3	52.8	6.3	6.7	17.5	4.9	33.8
Beta 4776R	Betaseed, 1-19-99, resist ck	42.3	36.7	86.9	1.0	5.0	12.4	2.8	98.8
US H11	susc. check	36.7	28.0	75.5	2.7	5.9	16.5	5.6	10.2
Checks									
SS-432R	Spreckels, 2-8-99	37.4	38.1	100.0	0.7	3.6	9.7	3.7	71.8
Beta 4430R	Betaseed, 3-10-99	43.1	38.1	88.8	1.1	8.0	18.0	2.6	98.3
Beta 4776R	Betaseed, 1-19-99	43.9	37.7	86.0	0.6	4.0	9.3	3.0	97.3
Beta 4035R	Betaseed	40.6	34.9	86.3	0.9	5.6	13.6	3.1	93.5
KWS 6770	Betaseed	35.1	28.4	81.6	3.1	6.7	19.7	5.1	24.7
US H11	susc. check	37.7	31.7	84.8	1.6	5.7	14.8	5.4	14.2
Betaseed entries									
6CG7265	rec'd 3-22-99	42.1	31.1	73.8	2.0	10.6	25.5	3.5	83.3
7CG7275		39.7	36.9	93.1	0.3	1.6	3.8	2.9	94.4
7KJ5073		39.6	22.7	58.3	4.1	9.7	24.4	3.3	83.7
7KY5109		39.9	29.4	74.0	2.1	8.7	21.6	3.2	95.1
8CG7343		42.9	35.9	84.1	1.1	7.3	16.9	3.0	93.8
USDA entries									
R778%H50(Iso)	C790-15CMS x RZM R778% (C78)	41.6	24.6	59.0	3.4	9.7	23.2	3.8	70.1
R882H27	6831-4HO x R781,R776 (C82)	35.3	34.3	97.3	0.4	2.1	6.5	3.3	87.3
Y869H50	C790-15CMS x Y769 (C69)	39.7	26.6	69.4	2.9	7.6	18.7	3.5	75.4
Y869H27	C831-4HO x Y769 (C69)	37.4	26.0	72.6	2.3	9.0	22.9	3.5	79.1
Y869H5	C833-5aa x Y769 (C69)	35.9	29.4	84.3	1.0	4.6	11.6	3.0	96.9
Y875H50 (Iso)	C790-15CMS x RZM Y775	39.6	23.9	61.8	4.3	8.3	21.2	3.6	73.5
8926H50 (Iso)	C790-15CMS x RZM 7926	39.4	25.3	63.8	2.3	11.0	27.6	3.5	83.2
8936H50	C790-15CMS x RZM R776-89-5H31	39.0	30.0	76.2	1.6	6.3	16.6	3.4	86.2
8939H50	C790-15CMS x RZM Y769H31	39.6	19.7	50.8	5.4	9.9	24.6	3.7	67.1

TEST 5099. WESTERN SUGAR, BETASEED, & USDA HYBRID EVALUATION UNDER RHIZOMANIA, SALINAS, CA., 1999

(cont.)

Variety	Description	Stand Count Mean	Harv. Count Mean	Survival %	Missing Feet Mean	No. Rot Mean	Root Rot (Stand) %	Rhizomania Resistance DI	Rhizomania Resistance %R(0-4)
Mean		39.8	31.1	78.5	2.1	6.0	15.1	3.7	70.0
LSD (.05)		3.9	7.7	18.8	2.3	4.6	11.3	0.4	10.4
C.V. (%)		9.4	23.7	22.7	102.3	73.1	71.4	9.2	14.1
F value		3.8**	4.3**	4.4**	4.1**	3.3**	3.3**	47.9**	68.4**

NOTES: Rhizomania - Entries were evaluated using root scores. Sugar and root yield data were not collected. Because of the effects of root rot caused by *Sclerotium rolfsii*, it did not appear that yield data would be meaningful. Roots not infected with *S. rolfsii* were scored for reaction to rhizomania. These data appear to be valid and little affected by rot. Problems occurred in the collection of data for Rep. 5. After reviewing the ANOVA for 7 or 8 reps, rep. 5 was deleted. Plots were lifted and layed out by hand. Individual roots that were not severely damaged by rot were scored for rhizomania based on a scale of 0 to 9 where 0 to 4 were considered variations in resistance and 5 to 9, variations in susceptibility.

DI = disease index, is the mean score of all roots in an entry. The lower the score, the lesser the visual effects of rhizomania.

%R(0-4) = percentage of plants that appeared to be resistant based on checks and experience with reactions to disease conditioned by the *Rz* allele. Obviously, the segregation of plants into discrete resistant vs. susceptible classes did not occur. For example, about 12% of uniformly susceptible US H11 was scored resistant. Likewise, it is likely that some genotypically resistant plants were scored as being susceptible.

Overall, the DI and %R values appear to give a good fit to the known relative reactions of the checks and previously tested commercial and experimental hybrids. The reaction to rhizomania data appears to have good reliability.

(cont.)

Variety	Description	Stand Count	Harv. Count	Survi-val	Missing Feet	No. Rot	Root Rot (Stand)	Rhizomania Resistance	
		Mean	Mean	%	Mean	Mean	%	DI	%R(0-4)

NOTES: (cont.)

Sclerotium rolfsii - Southern root rot caused by *sclerotium rolfsii* occurred throughout this trial. Counts were made in an effort to determine if these varieties had differential reaction to *S.rolfsii* and if host-plant resistance could be detected.

Stand count = mean number of plants counted after thinning (prior to canopy closure).

Harvest count = number of roots per plot scored for rhizomania. Does not include roots with *S.rolfsii*.

No. Rot = number of roots counted at harvest that had root rot, most likely due to *S.rolfsii*.

% Root Rot = percentage of roots with rot at harvest in relationship to initial stand counts.

Missing Feet of Plot = measurement of linear feet of row in which rot had destroyed or rotted beets.

S.rolfsii was first detected when original stand counts were made. These small plants were quickly destroyed by rot and disappeared without trace. Infection occurred progressively through out the growing season, usually moving laterally, plant-to-plant within a plot row. The best indication of sensitivity to *S.rolfsii* might be the differences between the original stand count and the number of plants that could be scored for rhizomania (% survival). For example, US H11, Monohikari and some of the transgenics appeared to be highly sensitive to *S.rolfsii*, whereas Rizor, Beta 4776R et al. appeared to be much less sensitive. However, it also seemed that the rhizomania susceptible checks and entries were more susceptible to *S.rolfsii* than the rhizomania resistant entries. It may be that resistant, sound roots are more difficult to infect and rot than rhizomania impaired roots. Under the conditions of this test there appeared to be a definite differential varietal reaction to *S.rolfsii*. (If rhizomania resistant roots are more difficult to infect and rot, then a genetic analysis might suggest that the *Rz* allele was conditioning partial resistance to *S.rolfsii*).

USDA entries - C790-15CMS = rhizomania susceptible, monogerm tester. C78, C82, C69, R76-89-5H31 & Y769H31 segregate for *Rz*. Y775 & 7926 segregate for resistance from *Beta maritima*.

TEST 5199. CBGA CODED RHIZOMANIA TEST, SALINAS, CA., 1999

78 entries x 8 reps, RCB
1-row plots, 22 ft. long

Planted: April 29, 1999
Not harvested for yield
Scored: October 14-19, 1999

Code No.	Variety	Source	Stand Count Mean	Harv. Count Mean	Survival %	Missing Feet Mean	No. Rot Mean	Root Rot (Stand) %	Rhizomania Resistance DI	Rhizomania Resistance %R(0-4)
SR- 1	SS-338R	Spreckels	40.1	39.0	97.4	0.3	1.5	3.7	3.7	70.6
- 2	Beta 4684R	Betaseed	43.6	40.5	93.6	0.6	4.1	9.1	3.0	94.8
- 3	98HX853	Spreckels	39.8	38.3	96.1	0.8	2.6	6.7	3.3	86.5
- 4	98CX20	Spreckels	44.1	36.9	84.1	1.3	5.4	11.8	3.6	72.1
- 5	Beta 4419R	Betaseed	41.3	35.3	85.4	2.5	3.5	8.3	3.7	69.2
- 6	98CX28	Spreckels	38.9	36.6	94.4	1.4	3.4	8.5	3.7	68.9
- 7	Rival	Spreckels	35.8	36.1	100.0	0.4	0.5	1.1	3.1	92.7
- 8	H93203	Spreckels	37.8	33.8	89.6	1.3	3.8	9.9	3.4	81.5
- 9[1]	Beta 4776R substituted	Betaseed	42.0	41.0	97.9	0.6	1.9	4.4	3.0	96.5
-10	99HX916	Spreckels	40.8	37.1	92.0	0.4	5.4	12.9	3.4	82.8
-11	Rodeo	Spreckels	42.1	37.6	89.6	0.5	4.0	9.3	3.2	88.5
-12	SS-289R	Spreckels	40.3	38.9	97.5	0.6	2.8	6.7	4.0	62.1
-13	7CG7376	Betaseed	44.9	34.4	76.7	1.1	7.1	15.7	2.9	97.9
-14	98CX29	Spreckels	39.4	36.6	93.7	0.8	4.6	11.7	3.4	82.6
-15	H93392	Spreckels	39.5	35.5	89.7	0.9	3.4	8.8	3.4	79.3
-16	Pinnacle	Spreckels	37.0	35.5	95.5	0.9	2.6	7.5	3.2	87.2
-17	4KJ0166	Betaseed	35.0	24.9	70.8	2.3	7.4	20.6	3.2	90.5
-18	7CG7303	Betaseed	37.9	36.9	100.0	1.4	3.9	9.8	3.0	95.3
-19	7CG7410	Betaseed	40.9	34.1	84.0	2.1	8.9	22.1	3.7	71.6
-20	98CX21	Spreckels	41.6	37.5	92.8	2.0	4.9	12.0	3.4	83.0
-21	SS-781R	Spreckels	37.4	35.0	94.9	0.5	4.5	11.7	3.5	79.3
-22[2]	5CG7540	Betaseed	42.0	36.0	86.8	0.6	5.8	13.2	3.4	82.4
-23	7CG7373	Betaseed	39.1	27.0	69.1	2.4	8.3	20.9	4.5	42.4
-24	99HX913	Spreckels	39.5	37.3	94.5	0.4	2.6	6.3	3.5	73.0
-25	97CX14	Spreckels	40.0	39.0	98.4	0.4	4.0	9.7	3.6	74.4

TEST 5199. CBGA CODED RHIZOMANIA TEST, SALINAS, CA., 1999

(cont.)

Code No.	Variety	Source	Stand Count Mean	Harv. Count Mean	Survival %	Missing Feet Mean	No. Rot Mean	Root Rot (Stand) %	Rhizomania Resistance DI	Rhizomania Resistance %R(0-4)
SR-26	Rizor	Spreckels	37.6	34.5	92.1	0.8	3.5	9.1	3.3	89.5
-27	Beta 4488R	Betaseed	41.3	29.0	69.7	2.4	9.9	24.4	3.3	89.7
-28	H945187	Spreckels	39.4	28.3	73.2	2.3	8.8	21.4	3.7	72.4
-29	98CX16	Spreckels	42.6	40.6	95.5	0.8	2.5	5.7	3.7	72.5
-30	SS-432R	Spreckels	39.1	35.3	91.4	0.9	4.0	9.8	4.0	61.3
-31	98CX19	Spreckels	39.4	34.1	87.1	1.0	6.0	15.0	3.7	68.4
-32	98CX857	Spreckels	38.8	38.4	100.0	0.4	2.6	7.0	3.7	70.1
-33	7KJ0146	Betaseed	40.9	34.0	84.7	0.9	4.6	10.5	2.8	95.9
-34	Alpine	Spreckels	39.9	37.0	93.5	1.0	2.3	5.5	3.4	81.7
-35	H92463	Spreckels	37.4	31.9	86.3	1.6	5.8	15.0	4.0	57.6
-36	98CX30	Spreckels	40.1	35.5	88.2	0.9	3.4	8.6	3.5	78.8
-37	5KJ5057	Betaseed	40.4	33.9	84.0	1.6	6.5	15.9	3.1	94.2
-38	4KJ0164	Betaseed	42.5	31.8	75.1	2.0	7.5	17.8	3.0	96.5
-39	99HX915	Spreckels	34.3	26.4	76.8	2.6	8.1	24.1	3.6	74.1
-40	98CX31	Spreckels	40.8	39.5	96.8	0.4	3.3	8.2	3.5	75.9
-41	99HX918	Spreckels	38.0	30.6	81.1	1.5	6.3	16.1	3.6	72.3
-42	98CX23	Spreckels	40.0	38.6	96.2	0.4	2.0	5.6	3.3	86.6
-43	98CX32	Spreckels	36.6	34.3	93.8	1.1	3.1	8.6	3.4	80.0
-44	Beta 4210R	Betaseed	36.3	23.6	66.7	3.5	9.3	25.4	3.3	88.7
-45	99HX912	Spreckels	38.4	25.1	66.5	4.5	9.3	24.5	3.1	94.9
-46	Beta 4300R	Betaseed	42.1	25.3	60.7	3.3	12.3	28.7	3.0	91.7
-47	H95555	Spreckels	38.4	29.4	77.2	2.9	8.9	23.0	3.9	61.0
-48	7KJ0191	Betaseed	42.4	36.4	86.4	0.6	5.0	11.6	3.0	97.5
-49	6CG7492	Betaseed	34.6	22.4	66.3	3.3	11.4	32.6	3.3	86.3
-50	SS-778R	Spreckels	38.1	25.5	68.7	3.4	11.5	30.4	4.0	57.5
-51	Rifle	Spreckels	40.0	24.1	60.4	3.6	9.6	23.9	3.3	88.3
-52	7CG7408	Betaseed	40.4	27.6	67.6	3.0	9.0	23.0	3.7	68.7
-53	US H11	Standard	30.4	25.9	85.5	2.3	5.4	17.6	5.5	8.7

TEST 5199. CBGA CODED RHIZOMANIA TEST, SALINAS, CA., 1999

(cont.)

Code No.	Variety	Source	Stand Count Mean	Harv. Count Mean	Survival %	Missing Feet Mean	No. Rot Mean	Root Rot (Stand) %	Rhizomania Resistance DI	Rhizomania Resistance %R(0-4)
SR-54	7CG7321	Betaseed	42.9	24.1	56.8	4.0	11.3	26.3	3.2	88.6
-55	5KJ0142	Betaseed	44.6	39.8	88.9	0.5	4.8	10.8	2.7	97.7
-56	99HX914	Spreckels	39.1	35.1	90.2	0.4	2.8	6.9	3.5	79.4
-57	98CX861	Spreckels	36.3	30.4	84.4	1.5	5.0	14.0	4.1	55.0
-58	Imperial	Spreckels	36.4	32.9	91.0	1.1	3.4	9.3	3.5	77.5
-59	SS-NB7R	Spreckels	39.3	36.9	93.9	0.5	3.1	7.9	3.4	84.6
-60	6KJ0163	Betaseed	41.6	27.9	67.6	2.4	11.0	27.2	3.0	93.0
-61	Beta 4776R	Betaseed	42.0	41.0	97.9	0.6	1.9	4.4	3.0	96.5
-62	7CG7400	Betaseed	41.1	25.4	63.1	2.3	10.5	24.6	3.3	89.7
-63	Beta 4430R	Betaseed	44.5	41.3	92.4	0.1	3.8	8.6	2.8	93.3
-64	Beta 4035R	Betaseed	38.4	35.0	91.6	0.5	4.9	12.4	3.0	92.7
-65	7CG7621	Betaseed	34.8	25.1	72.5	4.3	6.8	19.9	5.6	9.6
-66	Summit	Spreckels	42.3	36.4	86.3	0.9	5.9	14.0	3.4	81.5
-67	97CX01	Spreckels	41.0	36.8	90.2	0.1	2.4	5.5	3.4	83.7
-68	99HX917	Spreckels	37.4	31.3	82.5	1.9	8.0	21.7	3.9	64.6
-69	98CX858	Spreckels	37.5	34.4	91.6	1.0	3.4	9.0	3.7	71.8
-70	Phoenix	Spreckels	37.9	37.4	99.3	0.9	1.8	4.4	3.3	84.5
-71	8CG7064	Betaseed	41.6	23.5	56.7	4.1	13.0	31.4	4.8	25.7
-72	7CG7322	Betaseed	42.0	35.6	86.5	0.6	4.5	10.2	2.9	99.7
-73	99HX926	Spreckels	38.8	37.6	98.3	0.8	3.0	7.4	3.5	78.3
-74	99HX928	Spreckels	39.3	38.4	97.9	0.1	2.6	6.8	3.3	85.8
-75	99HX923	Spreckels	42.3	32.8	78.1	1.9	7.4	17.4	4.2	50.9
-76	99HX925	Spreckels	39.5	29.4	74.5	2.1	7.6	19.0	3.6	74.0
-77	99HX924	Spreckels	39.0	34.0	87.0	1.5	3.9	10.2	4.0	59.5
USDA check										
78	US H11 susc ck	USDA	39.0	30.8	78.6	2.0	8.0	20.6	5.2	12.4

TEST 5199. CBGA CODED RHIZOMANIA TEST, SALINAS, CA., 1999

(cont.)

Code No.	Variety	Source	Stand Count	Harv. Count	Survi-val	Missing Feet	No. Rot	Root Rot (Stand)	Rhizomania Resistance	
			Mean	Mean	%	Mean	Mean	%	DI	%R(0-4)
Mean			39.5	33.1	84.3	1.6	5.6	14.2	3.5	76.9
LSD (.05)			4.1	6.9	16.2	1.8	3.9	9.8	0.3	9.4
C.V. (%)			10.5	21.1	19.5	117.8	71.9	70.8	7.8	12.4
F value			3.3**	5.0**	4.8**	4.2**	4.4**	4.7**	31.9**	33.0**

[1]Entry 9 had 0% emergence. Beta 4776R transplants used as filler.
[2]Entry 22 had low frequency of bolters (annuals)

NOTES: Rhizomania - Entries were evaluated using root scores. Sugar and root yield data were not collected. Because of the effects of root rot caused by *Sclerotium rolfsii*, it did not appear that yield data would be meaningful. Roots not infected with *S. rolfsii* were scored for reaction to rhizomania. These data appear to be valid and little affected by rot. Plots were lifted and layed out by hand. Individual roots that were not severely damaged by rot were scored for rhizomania based on a scale of 0 to 9 where 0 to 4 were considered variations in resistance and 5 to 9, variations in susceptibility.

DI = disease index, is the mean score of all roots in an entry. The lower the score, the lesser the visual effects of rhizomania.

%R(0-4) = percentage of plants that appeared to be resistant based on checks and experience with reactions to disease conditioned by the *Rz* allele. Obviously, the segregation of plants into discrete resistant vs. susceptible classes did not occur. For example, about 12% of uniformly susceptible US H11 was scored resistant. Likewise, it is likely that some genotypically resistant plants were scored as being susceptible.

Overall, the DI and %R values appear to give a good fit to the known relative reactions of the checks and previously tested commercial and experimental hybrids. The reaction to rhizomania data appears to have good reliability.

TEST 5199. CBGA CODED RHIZOMANIA TEST, SALINAS, CA., 1999

(cont.)

Code No.	Variety	Source	Stand Count	Harv. Count	Survi-val	Missing Feet	No. Rot	Root Rot (Stand)	Rhizomania Resistance	
			Mean	Mean	%	Mean	Mean	%	DI	%R(0-4)

NOTES: (cont.)

Sclerotium rolfsii - Southern root rot caused by *sclerotium rolfsii* occurred throughout this trial. Counts were made in an effort to determine if these varieties had differential reaction to *S.rolfsii* and if host-plant resistance could be detected.

Stand count = mean number of plants counted after thinning (prior to canopy closure).

Harvest count = number of roots per plot scored for rhizomania. Does not include roots with *S.rolfsii*.

No. Rot = number of roots counted at harvest that had root rot, most likely due to *S.rolfsii*.

% Root Rot = percentage of roots with rot at harvest in relationship to initial stand counts.

Missing Feet of Plot = measurement of linear feet of row in which rot had destroyed or rotted beets.

S.rolfsii was first detected when original stand counts were made. These small plants were quickly destroyed by rot and disappeared without trace. Infection occurred progressively through out the growing season, usually moving laterally, plant-to-plant within a plot row. The best indication of sensitivity to *S.rolfsii* might be the differences between the original stand count and the number of plants that could be scored for rhizomania (% survival). For example, US H11 and some of the more susceptible entries appeared to be highly sensitive to *S.rolfsii*, whereas Beta 4430R, Beta 4776R et al. appeared to be much less sensitive. However, it also seemed that the rhizomania susceptible checks and entries were more susceptible to *S.rolfsii* than the rhizomania resistant entries. It may be that resistant, sound roots are more difficult to infect and rot than rhizomania impaired roots. Under the conditions of this test there appeared to be a definite differential varietal reaction to *S.rolfsii*. (If rhizomania resistant roots are more difficult to infect and rot, then a genetic analysis might suggest that the *Rz* allele was conditioning partial resistance to *S.rolfsii*).

TEST B199. EVALUATION OF TESTCROSS HYBRIDS, IMPERIAL VALLEY, CA., 1998-99

32 entries x 8 replications, RCB(E)
1-row plots, 27 ft. long (16 blocks, 16 rows)

Planted: September 23, 1998
Harvested: June 15, 1999

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Bolters %	Clean Beets %	NO3-N Mean
Checks								
B4776R	Beta 4776R.7653 (3-27-98)	10607	35.93	14.69	155	0.0	92.6	188
Rifle	Spreckels, 9-98, L1162401	11016	37.50	14.71	149	1.5	94.5	190
Testcrosses to C306/2CMS								
Y869H37	4807HO (C306/2CMS) x Y769	10984	42.64	12.87	137	0.3	94.8	211
R882H37	4807HO (C306/2CMS) x R781,R776	9330	39.25	11.82	139	0.0	95.1	223
Testcrosses to C790-15CMS								
R576-89-18H50	C790-15CMS x R476-89-18	12106	40.65	14.90	150	2.1	93.8	143
R876-89-5NBH50[1]	C790-15CMS x RZM-% R576-89-5NB	10081[1]	33.02	15.29	136	1.3	93.0	111
R876-89-5H50	C790-15CMS x RZM-% R576-89-5	12305	41.62	14.77	154	0.6	94.0	133
R882H50	C790-15CMS x R781,R776	10460	36.21	14.43	140	0.3	94.4	148
Y869H50	C790-15CMs x Y769 (C69)	11658	39.99	14.58	142	1.6	94.2	174
Y868H50	C790-15CMS x RZM Y768	11083	38.83	14.18	145	0.0	94.3	171
R878H50	C790-15CMS x R778,R778% (C78)	11606	39.16	14.82	133	1.7	94.4	147
R854H50	C790-15CMS x RZM R754	10902	38.51	14.17	148	0.7	93.3	148
Y873BH50	C790-15CMS x RZM Y773	10616	37.62	14.07	147	1.6	94.1	187
Y875H50	C790-15CMS x RZM Y775,…	10457	36.89	14.18	141	1.0	93.4	172
Y866H50	C790-15CMS x RZM Y766	11505	38.93	14.76	147	1.0	94.4	172
Y867H50	C790-15CMS x RZM Y767 (C67)	10386	37.64	13.84	148	0.6	94.4	183
Y871H50	C790-15CMS x RZM Y771	12937	44.31	14.62	151	1.5	95.0	128
Y872BH50	C790-15CMS x RZM Y772 (C72)	12216	43.07	14.13	147	0.0	93.9	161
Y872H50	C790-15CMS x RZM-% Y672	12913	45.30	14.29	160	2.6	93.5	188
8931H50	C790-15CMS x RZM 7931	11890	41.55	14.33	145	0.3	93.3	160

TEST B199. EVALUATION OF TESTCROSS HYBRIDS, IMPERIAL VALLEY, CA., 1998-99

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Bolters %	Clean Beets %	NO3-N Mean
Testcrosses to C790-15CMS (cont.)								
8924H50	C790-15CMS x RZM 7924	11569	41.10	14.05	144	0.7	93.7	159
8932H50	C790-15CMS x 7932CT,7201…	10793	37.87	14.37	140	2.8	92.6	186
Z831H50	C790-15CMS x RZM Z730,Z731	11446	41.38	13.81	144	0.3	93.2	168
8926H50	C790-15CMS x RZM 7926	11309	37.72	15.04	155	1.3	92.5	116
8913-70H50	C790-15CMS x RZM-ER-% C913-70	12832	44.23	14.46	150	0.3	93.5	183
8935H50	C790-15CMS x R776-89-5H13	12560	42.94	14.60	146	0.3	93.8	139
8936H50	C790-15CMS x RZM R776-89-5H31	11222	37.60	14.96	139	0.7	92.8	131
8937H50	C790-15CMS x RZM R776-89-5H11	12041	40.10	15.03	150	0.0	93.9	117
8938H50	C790-15CMS x RZM Z731H11	12218	40.87	15.01	157	1.0	94.3	129
8939H50	C790-15CMS x RZM Y769H31	11569	40.16	14.46	145	1.6	93.0	124
8918-12H50	C790-15CMS x RZM-ER-% 6918-12	12325	43.20	14.29	126	0.3	95.2	164
8918-21H50	C790-15CMS x RZM 7918-21	9785	31.97	15.28	127	0.3	93.4	109
Mean		11397.8	39.62	14.40	144.9	0.9	93.8	158.2
LSD (.05)		1298.8	3.83	0.78	11.1	1.7	1.5	56.0
C.V. (%)		11.6	9.80	5.47	7.8	195.8	1.6	36.0
F value		3.9**	5.09**	5.90**	4.0**	1.6NS	2.0**	2.1*

NOTE: The pollinators of these experimental hybrids are breeding lines and populations under population improvement in the breeding program at Salinas. Lines R754, Y766, Y767, Y771, Y772, Y773, Y775, and 7926 have resistance to rhizomania and germplasm from *Beta vulgaris* ssp. *maritima*. R776-89-5H13 = F_1 (C913-70aa x C76-89-5), R776-89-5H31 = F_1 (popn-931aa x C76-89-5), R776-89-5H11 = F_1 (C911-4aa x C76-89-5), Z731H11 = F_1 (C911-4aa x CZ25), and Y769H31 = F_1 (popn-931aa x C69) are F_1 population and line hybrids that are being evaluated and developed as potential sources for S_1 progeny selection for combined disease resistance and performance. Individual plants within these F_1 hybrids should be Aa,S^f, and segregate for resistance to rhizomania, virus yellows, bolting, etc. S_1 progenies from these F_1 hybrids are being evaluated at Brawley for nonbolting and resistance to rhizomania and at Salinas for nonbolting, virus yellows resistance, performance per se, and for resistance to rhizomania, powdery mildew, and *Erwinia*.

[1]R876-89-5NBH50 had appearance of C76-89-5 pollinator and not its H50 hybrid. Pollinator seed may have been planted.

TEST B399. EVALUATION OF EXPERIMENTAL HYBRIDS (POPN & S_1 PROGENY TESTCROSSES), IMPERIAL VALLEY, CA., 1998-99

32 entries x 8 reps., RCB(e), 2 blocks per rep
1-row plots, 27 ft. long, 16 blocks, 16 rows

Planted: September 23, 1998
Harvested: May 17, 1999[1]

Variety[2]	Description[2]	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Bolters	Root Rot	Clean Beets[3]	NO3-N
		Lbs	Tons	%	No.	%	%	%	Mean
Checks									
Rizor	Holly HH108, 9-3-97	12131	39.58	15.31	163	3.5	0.0	89.3	93
SS-778R	Spreckels, 9-98, L782402	11887	41.11	14.44	160	0.8	0.0	90.0	102
Rifle	Spreckels, 9-98, L1162401	11859	38.97	15.18	165	2.1	0.0	92.1	107
B4776R	Beta 4776R.7653 (3-27-98)	11034	35.70	15.49	166	0.0	0.0	92.1	96
R878H50	C790-15CMS x R778, R778%	11533	40.11	14.36	155	5.6	0.0	92.0	110
R882H50	C790-15CMS x R781, R776,…	10876	38.02	14.31	155	0.0	0.7	92.8	116
Population hybrids									
8931H50	C790-15CMS x RZM 7931	11693	39.85	14.69	149	0.3	0.4	92.1	93
8924H50	C790-15CMS x RZM 7924	10359	35.82	14.50	154	2.6	0.0	91.5	122
S_1 Progeny Hybrids									
8913-70H50	C790-15CMS x RZM-ER-% 6913-70	9788	36.29	13.44	165	3.4	0.0	90.1	122
8911-4-10H50	C790-15CMS x RZM-ER-% 6911-4-10	10089	32.84	15.38	163	0.8	0.0	81.7	32
8918-12H50	C790-15CMS x RZM-ER-% 6918-12	10975	38.41	14.36	143	1.9	0.0	90.0	94
8918-21H50	C790-15CMS x RZM 7918-21	10018	32.66	15.38	131	0.0	0.0	89.8	92
8925-19H50	C790-15CMS x 6925-19	12336	44.28	14.05	160	0.0	0.0	90.6	105
8929-41H50	C790-15CMS x 6929-41	12219	40.84	14.97	162	0.0	0.0	88.0	77
8929-72H50	C790-15CMS x 6929-72	11210	36.84	15.21	157	0.3	0.0	91.6	64
8929-102H50	C790-15CMS x 6929-102	12258	41.73	14.64	156	1.2	0.0	93.2	103
8929-112H50	C790-15CMS x 6929-112	11503	37.90	15.19	158	3.6	0.0	90.7	81
8929-114H50	C790-15CMS x 6929-114	11800	38.11	15.47	153	0.3	0.3	90.6	57
8929-115H50	C790-15CMS x 6929-115	10919	35.39	15.47	147	1.5	0.0	89.5	76
8929-133H50	C790-15CMS x 6929-133	6710	21.43	15.69	139	0.0	0.0	85.1	61

TEST B399. EVALUATION OF EXPERIMENTAL HYBRIDS (POPN & S_1 PROGENY TESTCROSSES), IMPERIAL VALLEY, CA., 1998-99

(cont.)

Variety[2]	Description[2]	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Bolters	Root Rot	Clean Beets[3]	NO3-N
		Lbs	Tons	%	No.	%	%	%	Mean
S_1 Progeny Hybrids (cont.)									
8930-19H50	C790-15CMS x 6930-19	12582	41.95	14.96	158	0.0	0.0	90.2	84
8930-39H50	C790-15CMS x 6930-39	12030	40.57	14.85	161	0.0	0.0	90.7	80
8930-102H50	C790-15CMS x 6930-102	10693	35.09	15.24	164	0.0	0.0	88.6	106
Z825-6H50	C790-15CMS x Z625-6	12388	41.41	14.99	167	1.9	0.0	89.8	82
Z825-9H50	C790-15CMS x Z625-9	10829	34.79	15.60	152	0.3	0.3	90.2	83
Z830-11H50	C790-15CMS x Z630-11	13284	45.80	14.48	160	5.6	0.0	91.5	90
8927-29H50	C790-15CMS x 6927-29	11030	36.21	15.28	155	2.3	0.0	90.6	68
8927-30H50	C790-15CMS x 6927-30	11372	36.99	15.35	170	0.8	0.0	86.3	57
8927-33H50	C790-15CMS x 6927-33	9280	30.50	15.26	160	5.6	0.0	88.5	83
8927-37H50	C790-15CMS x 6927-37	11137	38.55	14.46	157	16.8	0.0	91.5	115
8929-153H50	C790-15CMS x 6929-153	11287	38.38	14.79	159	0.0	0.0	92.4	78
8929-154H50	C790-15CMS x 6929-154	10593	37.55	14.11	158	0.0	0.0	89.1	127
Mean		11178.1	37.61	14.90	156.9	1.9	0.1	90.1	89.2
LSD (.05)		1297.9	3.84	0.87	12.2	3.5	0.5	2.2	40.0
C.V. (%)		11.8	10.37	5.92	7.9	182.8	878.7	2.5	45.5
F value		6.6**	10.23**	2.95**	3.5**	6.9**	0.9NS	8.8**	2.3**

[1]Harvested 11 days after last irrigation under moderately wet conditions and high fertility.

[2]R778,R778% = C78. R776 = C82. 7931 & 7924 = MM,S^f,A:aa popns. S_1 progeny were individually selfed plants from MM,S^f,A:aa popns. S_1's were selected at Salinas on basis of per se disease resistance and performance and testcrossed to C790-15CMS.

[3]See Test B499.

TEST B499. EVALUATION OF TOPCROSS HYBRIDS, IMPERIAL VALLEY, 1998-99 (B499)

16 entries x 8 reps., RCB(E), 2 blocks/rep
1-row plots, 24 + 3 ft. long, 16 blocks, 8 rows

Planted: September 23, 1998
Harvested: May 14, 1999

Variety	Description[2]	Acre Yield Sugar	Acre Yield Beets	Sucrose[3]	Beets/ 100'	Bolters	Root[1] Rot	Clean Beets	NO3-N
		Lbs	Tons	%	No.	%	%	%	Mean
Checks									
B4776R	Beta 4776R.7653 (3-27-98)	10572	35.57	14.86	169	0.0	0.0	91.5	162
Y869H50	C790-15CMS x Y769	9938	36.05	13.76	161	0.6	0.3	92.1	202
Y869H37	4807HO (C306/2CMS) x Y769	9230	36.70	12.59	156	0.0	0.0	92.8	217
Population hybrids									
Y869H35	7835mmaa x Y769	9105	34.35	13.30	147	0.3	0.9	94.6	210
Y869H38	7838mmaa x Y769	9702	35.72	13.57	148	0.3	1.9	94.7	151
Topcross hybrids									
Y869H7	6911-4-7HO x Y769	9798	36.49	13.40	147	0.0	0.6	92.3	156
Y869H45	7867-1HO x Y769	8999	35.03	12.81	147	0.9	0.9	91.0	198
Y869H46	7869-6HO x Y769	9181	35.42	12.97	157	0.6	0.6	91.7	158
Y869H27	6831-4HO x Y769	10156	38.61	13.16	151	0.6	2.6	94.0	167
Y869H4	5831-3aa x Y769	7456	28.74	13.07	129	0.0	8.4	95.0	161
Y869H5	5833-5aa x Y769	9468	34.11	13.86	154	0.0	3.3	92.9	142
Y869H12	5833-12aa x Y769	7917	30.44	12.97	147	0.3	7.2	95.7	180
Y869H29	5829-3aa x Y769	7769	28.17	13.78	155	0.0	2.5	93.4	139
Y869H15-2B	6818-2Baa x Y769	8058	30.73	13.14	150	0.0	2.4	91.8	165
Y869H15-6	6818-6aa x Y769	7696	28.55	13.48	153	0.0	9.8	95.3	157
Y869H15-21	6818-21aa x Y769	7050	25.63	13.80	123	0.0	13.4	93.9	159
Mean		8880.9	33.15	13.41	149.7	0.2	3.4	93.3	170.2
LSD (.05)		900.0	3.27	0.71	11.2	0.7	4.6	1.8	51.6
C.V. (%)		10.3	9.97	5.36	7.6	305.3	136.2	2.0	30.6
F value		11.2**	10.78**	4.58**	7.6**	1.5NS	6.0**	5.4**	1.7NS

TEST B499. EVALUATION OF TOPCROSS HYBRIDS, IMPERIAL VALLEY, 1998-99 (B499)

(cont.)

Variety	Description[2]	Acre Yield Sugar	Acre Yield Beets	Sucrose[3]	Beets/ 100'	Bolters	Root[1] Rot	Clean Beets	NO3-N
		Lbs	Tons	%	No.	%	%	%	Mean

[1]For many harvests on the IDRS, Brawley, it has been observed that differential reactions occur to an unknown crown/root rot. This malady is characterized by a crown and upper root infection that leads from superficial discoloration (jet black skin) to deeper, dry lesions, crown rot, root splitting, destruction of shoot (crown) and subsequent loss of root. During harvest, affected plants often break and the lower tap root is left in the ground. Infected plants often occur in multiples of 2 or more down a plot row. The best guess as to the cause of this crown/root rot is Rhizoctonia, although *Phoma* has also been suspected. Plants may be infected in the seeding stage or at more advanced stages. If in the seeding stage, the major problems is loss of stand. If in larger beets, the beet may show only superficial rot or may eventually completely rot and die. Of interest to breeders is the distinct genetic diversity and differential reactions among sugarbeet breeding lines and hybrids. Lines C562, C301, C306, C790-15, for example, appear to be mostly resistant. Many other monogerms appear to be somewhat to fully susceptible. Multigerm lines appear to be variable in their reaction. Experimental hybrids may be completely free of crown/root rot or may have a significant number of infected plants. In developing C790-15, for example, S_1 lines per se were evaluated at Brawley. Resistance to LIYV was the primary objective at the time but it was observed that wide differences occurred for reaction to the black forming crown/root rot. C790-15 was selected partially based upon its high resistance to this root rot. It is not known if this root rot is important in commercial fields in the Imperial Valley, where I have rarely seen it, or just in the field plot areas on the IDRS. Because of the availability of resistance to this disease, it may be that in the trialing process by researchers, seed companies, processors and growers, that the most susceptible materials do not yield well enough to be retained in the tests. At the very least, based upon observations within tests on the IDRS, Brawley, it will be wise to be aware of this potential problem. Counts in this test were made at harvest and under a full canopy. Actual incidence of this rot is probably much higher.

[2]Y769 = C69. 6911-4-7HO = C911-4-7CMS. 7867-1HO = C867-1CMS. 6831-4HO = C831-4CMS. 5831-3 = C831-3. 5833-5 = C833-5. 5833-12 = C833-12. 5829-3 = C829-3.

[3]Test was harvested very wet (8 days post irrigation) and under high nitrogen status.

TEST B299. AREA 5 CODED NON-RHIZOMANIA YIELD TEST, IMPERIAL VALLEY, CA., 1998-99

32 entries x 8 reps, RCB(E)
1-row plots, 27 ft. long

Planted: September 23, 1998
Harvested: June 11, 1999

Code	Variety	Source	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Bolters %	Clean Beets %	NO3-N Mean
98M -23	Beta 4430R	Betaseed	14731	45.40	16.23	160	0.0	94.3	90
-25	8CG7064	Betaseed	13304	43.27	15.33	160	1.2	95.3	88
-22	7CG7322	Betaseed	13449	44.45	15.11	149	5.1	94.1	133
-21	Summit	Spreckels	13011	44.61	14.56	148	0.3	93.9	117
- 1	7CG7321	Betaseed	12871	41.99	15.32	162	37.4	91.5	118
-18	SS-778R	Spreckels	12736	42.22	15.07	155	1.5	94.0	91
- 4	Beta 4035R	Betaseed	12712	41.54	15.29	158	2.7	94.0	130
- 2	Rizor	Spreckels	12432	39.24	15.85	154	9.5	93.9	122
-26	7KJ0191	Betaseed	12316	37.28	16.57	156	0.3	93.7	129
- 9	Phoenix	Spreckels	12079	41.75	14.45	160	1.7	95.2	193
-13	Rifle	Spreckels	11667	36.48	15.99	156	5.1	95.3	138
-10	Alpine	Spreckels	11695	39.76	14.68	153	2.9	94.7	124
-27	Beta 4776R	Betaseed	11335	35.89	15.81	159	0.0	94.3	124
- 6	7CG7400	Betaseed	11489	37.59	15.25	151	0.3	94.5	116
-19	98HX853	Spreckels	11311	37.62	15.05	149	2.2	94.4	110
-15	Beta 4684R	Betaseed	11175	35.46	15.74	164	1.4	95.0	102
-11	Beta 4210R	Betaseed	11697	43.30	13.51	154	0.3	96.2	255
-12	SS-NB7R	Spreckels	11288	38.04	14.81	160	1.9	95.5	136
-14	Pinnacle	Spreckels	11353	40.64	13.94	150	4.1	94.8	169
-16	SS-781R	Spreckels	11097	38.69	14.33	150	1.8	95.1	109
- 5	5CG7540	Betaseed	11021	37.20	14.83	160	5.2	92.5	143
- 7	97CX01	Spreckels	11153	38.33	14.52	160	0.9	94.2	118
- 8	Rival	Spreckels	10562	34.31	15.37	156	8.6	95.0	132
-17	Imperial	Spreckels	10354	37.35	13.83	149	2.6	95.3	188
-28	US H11	Standard	8020	27.75	14.41	136	0.4	92.7	117

TEST B299. AREA 5 CODED NON-RHIZOMANIA YIELD TEST, IMPERIAL VALLEY, CA., 1998-99

(cont.)

Code	Variety	Source	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Bolters %	Clean Beets %	NO3-N Mean
USDA entries									
R776-89-5H37	4807HO(C306/2CMS) x C76-89-5		12301	42.79	14.38	156	0.8	94.5	116
R876-89-5H50	C790-15CMS x C76-89-5		11786	37.66	15.67	156	5.4	94.0	84
R882H37	4807HO(C306/2CMS) x C82		11936	42.90	13.88	147	0.6	96.0	138
R878H50	C790-15CMS x C78		11325	37.46	15.11	154	8.5	94.5	106
R778H37	4807HO (C306/2CMS) x C78		11344	40.06	14.14	148	1.3	95.5	117
R882H27	C831-4HO x C82		11139	39.48	14.13	141	2.2	95.7	120
R882H50	C790-15CMS x C82		10727	36.18	14.86	145	3.2	95.3	120
Mean			11731.8	39.27	14.94	153.5	3.7	94.5	127.9
LSD (.05)			1206.4	3.82	0.54	11.1	3.5	1.1	39.4
C.V. (%)			10.4	9.89	3.66	7.4	94.9	1.1	31.3
F value			7.17**	6.98**	14.95**	2.6NS	28.3**	6.8**	5.7**

TEST B299. AREA 5 CODED NON-RHIZOMANIA YIELD TEST, IMPERIAL VALLEY, CA., 1998-99

(cont.)

Code	Variety	Recover. Sugar	Recover. Sugar	Recover. Sugar	Known SugarLoss	Sodium	Potassium	NH_2-N	Impur. Value
		lbs/a	lbs/t	%	lbs/a	ppm	ppm	ppm	
98M -23	Beta 4430R	13633	300	92.5	1097	301	1743	279	8060
-25	8CG7064	12192	281	91.6	1111	432	1648	312	8599
-22	7CG7322	12096	272	89.8	1353	431	2156	351	10232
-21	Summit	11635	260	89.3	1376	433	2194	352	10341
- 1	7CG7321	11612	276	90.1	1259	397	2082	364	10053
-18	SS-778R	11478	272	90.1	1258	418	2121	333	9931
- 4	Beta 4035R	11440	275	90.0	1272	351	2000	415	10169
- 2	Rizor	11335	289	91.2	1096	350	1879	354	9290
-26	7KJ0191	11273	304	91.7	1044	338	1805	363	9143
- 9	Phoenix	10807	258	89.2	1272	393	2017	413	10339
-13	Rifle	10535	289	90.2	1132	403	1907	444	10395
-10	Alpine	10533	264	89.8	1162	364	2090	347	9801
-27	Beta 4776R	10362	289	91.4	973	361	1751	350	8971
- 6	7CG7400	10213	271	88.7	1276	394	2305	452	11434
-19	98HX853	10178	271	89.9	1133	360	2176	354	10063
-15	Beta 4684R	10120	285	90.4	1055	430	1912	391	10002
-11	Beta 4210R	10102	233	86.1	1595	582	2453	441	12356
-12	SS-NB7R	10055	264	89.0	1234	402	2126	434	10841
-14	Pinnacle	10010	246	88.1	1343	533	2259	369	11021
-16	SS-781R	9946	257	89.5	1151	410	2026	363	9951
- 5	5CG7540	9826	265	89.1	1195	419	1960	458	10711
- 7	97CX01	9812	255	87.9	1341	439	2395	437	11679
- 8	Rival	9583	278	90.5	979	388	1991	355	9712
-17	Imperial	9125	244	88.1	1229	522	2249	363	10898
-28	US H11	7089	255	88.5	932	385	2194	446	11066

TEST B299. AREA 5 CODED NON-RHIZOMANIA YIELD TEST, IMPERIAL VALLEY, CA., 1998-99

(cont.)

Code	Variety	Recover. Sugar lbs/a	Recover. Sugar lbs/t	Recover. Sugar %	Known SugarLoss lbs/a	Sodium ppm	Potassium ppm	NH_2-N ppm	Impur. Value
USDA entries									
R776-89-5H37		10969	256	89.1	1332	446	2146	367	10410
R876-89-5H50		10658	284	90.4	1128	443	1836	400	9939
R882H37		10567	246	88.5	1369	422	2302	358	10632
R878H50		10187	272	89.9	1138	373	2082	379	10113
R778H37		9931	248	87.5	1412	419	2507	421	11733
R882H27		9775	248	87.8	1364	391	2454	419	11483
R882H50		9638	267	89.9	1089	335	1882	435	10008
Mean		10522.4	267.9	89.6	1209.4	408.3	2082.7	385.0	10293.1
LSD (.05)		1117.9	12.8	1.7	224.7	119.9	320.2	82.5	1558.0
C.V. (%)		10.8	4.8	2.0	18.9	29.8	15.6	21.8	15.4
F value		7.9**	13.9**	4.8**	3.3**	1.8*	3.6**	2.3**	2.7**

NOTES: Test was under fairly high nitrogen conditions. Entries 23 (tall canopy) and 25 (short canopy) were yellowish and appeared to be infected with LCV (lettuce chlorosis virus). Powdery mildew was controlled with sulfur. There appeared to be no significant disease or pest problems.

TEST B699. EVALUATION OF EXPERIMENTAL HYRIDS UNDER RHIZOMANIA, IMPERIAL VALLEY, CA., 1998-99

48 entries x 8 reps., RCB(E), 3 blocks per rep
1-row plots, 18 ft. long, 24 blocks, 16 rows

Planted: September 23, 1998
Harvested: May 13, 1999

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Bolters %	Root Rot %	Clean Beets %	NO3-N Mean
Checks									
B4776R	Beta 4776R.7653 (3-27-98)	8439	29.03	14.63	152	0.0	0.0	90.6	191
Rifle	Spreckels, 9-98, L1162401	8074	27.66	14.50	139	0.0	0.0	89.7	171
SS-778R	Spreckels, 9-98, L782402	7178	28.26	12.76	145	0.0	0.0	88.9	247
4035R	Betaseed, 7-10-97	7605	29.66	12.87	149	0.0	0.0	89.6	274
Testcrosses to C306/2CMS									
R776-89-5H37	4807HO (C306/2CMS) x R576-89-5	6851	27.55	12.51	139	0.0	0.0	88.0	281
R778H37	4807HO (C306/2CMS) x R678	6332	26.06	12.18	136	0.0	0.0	88.4	205
8926H37	4807HO (C306/2CMS) x RZM 7926	7366	31.78	11.67	135	0.0	0.0	88.0	286
Testcrosses to C790-15CMS									
R882H50	C790-15CMS x R781, R776	7695	30.16	12.78	139	0.0	0.0	90.2	259
R878H50(Sp)	C790-15CMS x R778, R778%	7542	29.96	12.68	145	1.4	0.0	88.8	215
Y869H50	C790-15CMS x Y769 (C69)	7442	29.61	12.63	144	0.0	0.0	90.3	303
R876-89-5NBH50	C790-15CMS x RZM-% R576-89-5NB	6060	20.94	14.57	133	0.5	1.6	80.6	124
Y873BH50	C790-15CMS x RZM Y773	6568	26.32	12.57	136	0.0	0.0	86.7	276
Y867H50	C790-15CMS x RZM Y767(C67)	7328	28.41	13.11	138	1.0	0.0	88.0	204
Y872H50	C790-15CMS x RZM-% Y672(C72)	8026	31.60	12.74	140	0.4	0.0	88.7	216
Y875H50 (Iso)	C790-15CMS x RZM Y775	6283	24.95	12.76	133	0.0	0.0	87.3	266
Y875H50 (Sp)	C790-15CMS x RZM Y775,	6886	27.64	12.53	138	0.4	0.0	88.3	258
CR813H50	C790-15CMS x RZM CR713	8483	33.78	12.67	149	1.8	0.0	90.0	229
8931H50 (Sp)	C790-15CMS x RZM 7931	7780	30.56	12.80	142	0.0	0.0	88.6	213
8924H50	C790-15CMS x RZM 7924	7526	27.88	13.51	138	0.0	0.0	88.9	157
Z831H50	C790-15CMS x RZM Z730,Z731	7664	30.10	12.80	145	0.0	0.0	89.4	237

TEST B699. EVALUATION OF EXPERIMENTAL HYRIDS UNDER RHIZOMANIA, IMPERIAL VALLEY, CA., 1998-99

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Bolters %	Root Rot %	Clean Beets %	NO3-N Mean
Testcrosses to C790-15CMS (cont.)									
8935H50 (Iso)	C790-15CMS x RZM R776-89-5H13	7467	27.75	13.51	144	0.5	0.0	88.1	229
8932H50	C790-15CMS x 7932CT,7201…	5982	22.50	13.47	140	1.5	0.0	85.5	174
8926H50 (Iso)	C790-15CMS x RZM 7926	7627	29.24	13.03	154	0.4	1.9	86.5	196
8926H50 (Sp)	C790-15CMS x RZM 7926	7693	29.66	12.98	141	0.5	0.0	87.5	194
Testcrosses to C831-4HO									
R882H27	6831-4HO x R781,R776	7466	31.19	12.13	131	0.5	0.0	92.8	261
Y869H27	6831-4HO x Y769	7595	30.54	12.48	140	0.5	0.0	89.9	252
Y875H27	6831-4HO x RZM Y775	7023	29.45	11.93	142	0.0	0.0	91.1	228
Testcrosses to popn-838, popn-835 & popn-869									
R882H38	7838mmaa x R781, R776	7371	27.63	13.38	129	0.0	0.0	89.0	147
Y869H38	7838mmaa x Y769	7758	30.16	12.90	134	0.0	0.0	91.7	223
Y869H35	7835mmaa x Y769	7085	27.33	13.00	152	0.0	0.0	91.1	247
Y869H69	7869aa x Y769	6879	26.16	13.17	149	0.4	0.0	90.2	218
R878H69	7869aa x R778,R778%	7909	29.79	13.33	149	0.7	0.0	89.6	195
8931H38	7838mmaa x RZM 7931	7533	29.12	12.96	147	0.0	0.0	88.5	203
8935H38	7838mmaa x R776-89-5H	7032	27.2213	12.93	145	0.9	0.0	88.5	182
8932H38	7838mmaa x 7932CT,720	6490	26.281…	12.49	145	0.0	0.0	88.6	217
R878H55	7835H50 x R778,R778%	7721	29.86	12.92	143	0.0	0.0	91.1	232
R878H58	7838H50 x R778,R778%	7904	29.63	13.31	145	1.4	0.0	89.2	177
8931H55	7835H50 x RZM 7931	7528	30.04	12.68	149	0.0	0.0	89.3	267
8931H58	7838H50 x RZM 7931	7599	29.99	12.82	135	0.5	0.0	88.2	204
8926H55	7835H50 x RZM 7926	7650	30.12	12.73	138	1.0	0.0	90.2	265
8926H58	7838H50 x RZM 7926	7981	31.96	12.48	141	0.5	0.0	88.4	231

TEST B699. EVALUATION OF EXPERIMENTAL HYRIDS UNDER RHIZOMANIA, IMPERIAL VALLEY, CA., 1998-99

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Bolters %	Root Rot %	Clean Beets %	NO3-N Mean
Topcrossed with C69									
Y869H4	5831-3aa x Y769	5471	22.13	12.44	120	0.0	8.3	91.4	203
Y869H5	5833-5aa x Y769	5972	23.05	12.98	129	0.0	2.9	91.0	198
Y869H12	5833-12aa x Y76	6754	25.639	13.21	133	0.5	0.0	92.0	199
Y869H29	5829-3aa x Y769	5973	22.77	13.19	148	0.0	0.0	89.9	148
Y869H45	7867-1HO x Y769	6813	27.02	12.60	140	1.9	0.0	91.1	265
Y869H46	7869-6HO x Y769	6450	25.46	12.69	148	0.8	0.5	87.7	212
Y869H7	6911-4-7HO x Y7	6495	26.8169	12.29	126	0.6	0.0	89.0	242
Mean		7215.6	28.13	12.90	140.7	0.4	0.3	89.1	221.2
LSD (.05)		930.6	3.31	0.75	15.5	1.2	2.1	3.2	71.7
C.V. (%)		13.1	11.94	5.93	11.2	317.8	655.4	3.7	32.9
F value		4.3**	5.39**	4.61**	1.7NS	1.4NS	3.1**	2.8**	2.4NS

Harvest under moist, high fertility conditions. Roots at harvest did not show obvious rhizomania symptoms but performance relative to tests in Field K without rhizomania suggested rhizomania was an important factor in yield. Sugarbeet cyst nematodes were observed at harvest. Powdery mildew was controlled with sulfur. Plants were probably infected with lettuce chlorosis virus (LCV) and BWYV although symptoms were mostly masked by the high fertility level.

TEST B799. HYBRID PERFORMANCE OF MONOGERM S_1 PROGENY LINES UNDER RHIZOMANIA, IMPERIAL VALLEY, CA., 1998-99

72 entries x 4 reps., RCB, 6 blocks per rep
1-row plots, 18 ft. long, 24 blocks, 12 rows

Planted: September 23-24, 1998
Harvested: May 12, 1999

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Bolters	Root Rot[1]	Clean Beets	NO3-N
		Lbs	Tons	%	No.	%	%	%	Mean
Checks									
Rifle	Spreckels, 9-98, L1162401	8420	32.17	13.08	152	2.7	0.0	88.4	15
Y869H37	4807HO (C306/2CMS) x Y769	8717	33.40	13.05	158	0.0	0.0	89.1	29
B4776R	Beta 4776R.7653 (3-27-98)	7967	34.32	11.60	132	2.2	0.0	89.3	45
Y869H50	C790-15CMS x Y769	6872	31.04	11.08	149	0.0	0.0	86.3	16
S_1 lines from popn-833									
Y869H35	7835aa x Y769	8130	33.00	12.32	153	0.0	0.0	89.5	42
Y869H5	5833-5aa (C833-5)	6185	26.18	11.81	140	0.0	0.0	87.1	25
Y869H33-1	7833-1aa x Y769	6453	30.77	10.52	152	1.9	0.0	90.6	18
Y869H33-3	7833-3aa x Y769	8029	34.38	11.68	136	0.0	0.0	90.3	27
Y869H33-10	7833-10aa x Y769	7162	28.48	12.63	156	0.0	0.0	89.9	26
Y869H33-11	7833-11aa x Y769	7193	30.30	11.86	133	0.9	0.0	91.4	23
Y869H33-12	7833-12aa x Y769	6564	28.17	11.68	136	0.0	5.8	93.9	27
Y869H12	5833-12aa (C833-12) x Y769	7298	30.44	11.99	132	0.0	2.0	91.8	12
S_1 lines from popn-834									
Y869H29	5829-3aa (C829-3) x Y769	6340	25.30	12.49	147	0.0	0.0	83.9	30
Y869H34-1	7834-1aa x Y769	6650	29.97	11.24	149	0.0	0.0	90.7	35
Y869H34-2	7834-2aa x Y769	7297	30.75	11.89	140	0.0	0.0	91.2	19
Y869H34-3	7834-3aa x Y769	6658	28.39	11.74	140	0.0	0.0	88.7	39
Y869H34-5	7834-5aa x Y769	6625	29.42	11.22	158	2.5	0.0	90.4	28
Y869H34-8	7834-8aa x Y769	7972	33.73	11.76	156	2.7	0.0	90.6	22
S_1 lines from popn-829									
Y869H28-9	7828-9aa x Y769	7673	32.30	11.85	147	0.0	0.0	88.3	18
Y869H28-10	7828-10aa x Y769	7742	31.46	12.31	143	0.0	1.1	87.3	15

TEST B799. HYBRID PERFORMANCE OF MONOGERM S_1 PROGENY LINES UNDER RHIZOMANIA, IMPERIAL VALLEY, CA., 1998-99

(cont.)

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Bolters	Root Rot[1]	Clean Beets	NO3-N
		Lbs	Tons	%	No.	%	%	%	Mean
S_1 lines from popn-869									
Y869H69	7869aa x Y769	6469	28.63	11.32	160	0.0	0.0	90.3	25
Y869H69- 1	7869- 1aa x Y769	8299	36.54	11.37	149	0.0	0.0	95.6	27
Y869H69- 2	7869- 2aa x Y769	6926	28.76	12.06	147	1.6	0.0	92.4	35
Y869H69- 4	7869- 4aa x Y769	7032	28.97	12.14	132	0.0	0.0	84.8	20
Y869H69- 5	7869- 5aa x Y769	7300	30.69	11.90	138	0.0	0.0	94.2	25
Y869H69- 6	7869- 6aa x Y769	7543	30.61	12.31	150	0.0	0.0	90.6	46
Y869H69- 7	7869- 7aa x Y769	6730	29.16	11.54	139	0.0	1.0	90.0	22
Y869H69-13	7869-13aa x Y769	7348	31.83	11.55	146	0.0	0.0	91.2	35
Y869H69-19	7869-19aa x Y769	7569	32.70	11.57	168	0.0	0.0	89.1	22
Y869H69-20	7869-20aa x Y769	6908	28.55	12.10	153	0.0	0.0	87.7	21
Y869H69-20B	7869-20Baa x Y769	6890	30.92	11.16	135	0.0	0.0	89.7	34
Y869H69-24	7869-24aa x Y769	7725	31.16	12.45	139	0.0	0.0	92.7	20
S_1 lines from popn-836									
Y869H38	7838aa x Y769	8106	32.83	12.32	139	0.0	0.0	89.6	40
Y869H36- 3	7836- 3aa x Y769	7270	30.57	11.88	115	0.0	0.0	89.5	36
Y869H36-11	7836-11aa x Y769	7789	32.96	11.91	136	0.0	0.0	89.0	17
Y869H36-14	7836-14aa x Y769	7313	30.25	12.09	103	0.0	0.0	91.0	23
S_1 lines from popn-837	85.9								
Y869H77-1	7837-1aa x Y769	7048	28.61	12.39	128	0.0	0.0	85.9	37
Y869H77-1B	7837-1Baa x Y769	6756	28.60	11.83	126	0.0	0.0	87.5	29
Y869H77-2	7837-2aa x Y769	6750	26.49	12.74	140	0.0	0.0	85.4	25
Y869H77-3	7837-3aa x Y767	7004	27.81	12.60	157	0.0	0.0	88.0	20
Y869H77-4	7837-4aa x Y769	5591	24.43	11.47	120	0.9	0.0	87.8	39

TEST B799. HYBRID PERFORMANCE OF MONOGERM S_1 PROGENY LINES UNDER RHIZOMANIA, IMPERIAL VALLEY, CA., 1998-99

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Bolters %	Root Rot[1] %	Clean Beets %	NO3-N Mean
S_1 lines from popn-839									
Y869H79-1	7839-1aa x Y769	6896	30.35	11.38	147	0.0	0.0	90.5	28
Y869H79-2	7839-2aa x Y769	7561	32.33	11.67	145	0.0	0.0	88.7	18
Y869H79-3	7839-3aa x Y769	6736	32.04	10.57	139	0.0	0.0	92.0	23
Y869H79-4	7839-4aa x Y769	6706	29.18	11.53	146	0.0	0.0	89.3	36
Y869H79-5	7839-5aa x Y769	7935	34.14	11.62	143	0.0	0.0	92.1	35
Y869H79-5B	7839-5Baa x Y769	6966	29.08	11.98	135	0.0	2.3	92.7	13
Y869H79-6	7839-6aa x Y769	6401	26.62	11.97	133	0.0	0.0	86.1	24
Y869H79-10	7839-10aa x Y769	7492	31.82	11.80	136	0.0	0.0	85.5	30
S_1 lines from popn-831-4									
Y869H4	5831-3aa (C831-3) x Y769	7362	30.88	11.97	122	0.0	0.0	92.9	28
Y869H27-1	7831-4-1aa x Y769	7200	31.78	11.29	124	0.0	0.0	89.4	26
Y869H27-2	7831-4-2aa x Y769	7506	33.70	11.12	128	0.0	0.0	89.5	46
Y869H27-7	7831-4-7aa x Y769	6465	29.01	11.15	133	0.0	0.0	89.0	30
Y869H27-8	7831-4-8aa x Y769	8824	37.24	11.90	131	0.0	0.0	92.4	30
Y869H27-9	7831-4-9aa x Y769	6077	26.96	11.31	118	0.0	0.0	91.1	19
Y869H27-10	7831-4-10aa x Y769	7373	32.63	11.37	125	0.0	0.0	87.2	40
S_1 lines from popn-808									
Y869H9-1	7808-1aa x Y769	7734	31.73	12.26	136	0.0	0.0	89.5	21
Y869H9-2	7808-2aa x Y769	7298	30.00	12.23	135	0.0	0.0	92.7	45
Y869H9-3	7808-3aa x Y769	7202	29.15	12.39	126	1.1	0.0	90.2	31
Y869H9-4	7808-4aa x Y769	7142	27.51	13.11	138	0.0	0.0	88.9	29
Y869H9-7	7808-7aa x Y769	6299	27.76	11.37	149	0.0	0.0	83.9	31
Y869H9-8	7808-8aa x Y769	6337	29.46	10.78	138	0.0	0.0	92.2	36
Y869H9-9	7808-9aa x Y769	6415	25.21	12.74	131	0.0	0.0	86.6	50

TEST B799. HYBRID PERFORMANCE OF MONOGERM S_1 PROGENY LINES UNDER RHIZOMANIA, IMPERIAL VALLEY, CA., 1998-99

(cont.)

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Bolters	Root Rot[1]	Clean Beets	NO3-N
		Lbs	Tons	%	No.	%	%	%	Mean
S_1 lines from popn-808 (cont.)									
Y869H9-12	7808-12aa x Y769	8216	33.96	12.07	150	0.0	0.0	88.8	32
Y869H9-13	7808-13aa x Y769	6974	29.32	11.77	146	0.0	1.9	91.0	48
Y869H9-16	7808-16aa x Y769	5174	23.32	11.02	133	0.0	1.0	89.6	12
S_1 lines from popn-818									
Y869H15-1B	6818-1Baa x Y769	7908	32.96	12.01	143	0.0	0.0	89.5	30
Y869H15-2B	6818-2Baa x Y769	7064	30.71	11.48	147	0.0	2.1	88.3	12
Y869H15-1	6818-1aa x Y769	6631	26.02	12.65	146	0.0	8.3	90.5	21
Y869H15-2	6818-2aa x Y769	8438	34.47	12.23	147	0.0	0.0	86.1	13
Y869H15-6	6818-6aa x Y769	7618	30.67	12.44	136	0.0	3.1	90.4	23
Y869H15-21	6818-21aa x Y769	6928	27.79	12.48	142	0.0	0.0	88.1	33
Mean		7183.2	30.3	11.86	140.0	0.2	0.4	89.5	27.6
LSD (.05)		1342.3	5.1	0.96	22.7	1.6	2.2	4.5	29.7
C.V. (%)		13.4	12.1	5.79	11.6	507.8	401.6	3.6	77.0
F value		2.1**	2.2**	2.68**	1.9**	1.3NS	2.7**	2.2**	0.8NS

NOTES: See Test B699. Test B799used as screen to identify monogerm lines with adaptation under rhizomania conditions to Imperial Valley.

[1]Root rot. See Test B499.

TEST B899. HYBRID PERFORMANCE OF MULTIGERM PROGENY LINES UNDER RHIZOMANIA, IMPERIAL VALLEY, CA., 1998-99

72 entries x 4 reps., RCB, 6 blocks per rep
1-row plots, 18 ft. long, 24 blocks, 12 rows

Planted: September 24, 1998
Harvested: May 11, 1999

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Bolters	Root Rot[1]	Clean Beets	NO3-N
		Lbs	Tons	%	No.	%	%	%	Mean
Checks									
B4035R	Betaseed, 7-10-97	7593	29.69	12.78	147	0.0	0.0	89.8	115
SS-778R	Spreckels, 9-98, L782402	7787	32.82	11.93	157	0.9	0.0	89.8	150
Rizor	Holly HH108, 9-3-97	8820	33.26	13.22	154	0.0	0.0	89.4	113
Rifle	Spreckels, 9-98, L1162401	8270	31.06	13.35	150	0.0	0.0	89.7	88
B4776R	Betaseed 4776R.7653 (3-27-98)	9240	32.98	13.99	153	0.0	0.0	90.3	109
Hybrids with *Bvm*, R22, C51 resistance									
R835H50	C790-15CMS x RZM R735 (C79-7)	6966	26.97	12.94	153	0.0	0.0	86.1	123
R836H50	C790-15CMS x RZM R736,R746(C79-8)	6729	28.33	11.88	131	0.0	0.0	88.0	117
R854H50	C790-15CMS x RZM R754	7291	29.37	12.41	149	0.0	0.0	86.8	136
Y873BH50	C790-15CMS x RZM Y773	7595	29.82	12.75	142	0.0	0.0	88.6	118
R879H50	C790-15CMS x RZM R779 (C79-1)	7130	30.27	11.74	139	1.0	0.0	91.3	122
Y867H50	C790-15CMS x RZM Y767 (C67)	8290	33.62	12.32	150	0.0	0.0	89.0	113
Y871H50	C790-15CMS x RZM Y771	7883	32.58	12.10	136	0.0	0.0	87.4	125
Y872H50	C790-15CMS x RZM-% Y672	7813	30.93	12.63	139	1.3	0.0	85.9	113
Y875H50	C790-15CMS x RZM Y775,…	7458	29.74	12.67	150	0.0	0.0	89.1	157
Y875H27	6831-4HO x RZM Y775,…	8394	33.85	12.39	150	2.7	0.0	89.3	136
Hybrids with *Rz*,*MM*,*S^f*,*Aa* lines									
8931H50	C790-15CMS x RZM 7931	7363	30.46	12.09	142	0.0	0.0	88.8	120
8925-19H50	C790-15CMS x 6925-19	9372	37.35	12.55	157	0.0	0.0	87.4	107
8913-70H50	C790-15CMS x RZM-ER-% 6913-70	8547	31.58	13.56	146	0.0	0.0	86.6	111
8911-4-10H50	C790-15CMS x RZM-ER-% 6911-4-10	7150	27.98	12.76	152	0.0	0.0	78.9	112

TEST B899. HYBRID PERFORMANCE OF MULTIGERM PROGENY LINES UNDER RHIZOMANIA, IMPERIAL VALLEY, CA., 1998-99

(cont.)

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Bolters	Root Rot[1]	Clean Beets	NO3-N
		Lbs	Tons	%	No.	%	%	%	Mean
Hybrids with *Rz*,MM,S^f,Aa lines (cont.)									
8918-12H50	C790-15CMS x RZM-ER-% 6918-12	9286	37.00	12.53	129	0.0	0.0	89.5	77
8918-21H50	C790-15CMS x RZM 7918-21	6099	23.31	13.05	125	0.0	0.0	86.3	120
Z825-6H50	C790-15CMS x Z625-6	8705	34.05	12.81	152	1.6	0.0	88.6	134
Z825-9H50	C790-15CMS x Z625-9	7334	26.39	13.93	139	0.0	0.0	87.7	105
Z830-11H50	C790-15CMS x Z630-11	8321	34.44	12.10	145	0.0	0.0	85.4	102
CR812H50	C790-15CMS x RZM CR712	7163	29.71	12.13	154	0.9	0.0	88.8	127
CR813H50	C790-15CMS x RZM CR713	8647	35.30	12.25	164	2.4	0.0	85.4	124
Hybrids with R22(C51),MM,S^f,Aa lines									
8926H50	C790-15CMS x RZM 7926	7927	29.86	13.24	152	0.9	0.0	85.7	89
8926H55	7835H50 x RZM 7926	7462	29.87	12.51	150	1.9	0.0	90.5	133
8926H58	7838H50 x RZM 7926	8793	35.55	12.37	167	1.7	0.0	89.3	115
8927-29H50	C790-15CMS x 6927-29	7938	30.50	12.99	140	0.0	0.0	88.2	107
8927-30H50	C790-15CMS x 6927-30	9141	35.07	13.05	153	0.0	0.0	86.0	93
8927-33H50	C790-15CMS x 6927-33	7852	29.99	13.11	150	1.0	0.0	87.5	112
8927-37H50	C790-15CMS x 6927-37	7751	32.07	12.10	128	6.9	0.0	89.9	104
Hybrids with C78,*Rz*,MM, S^f,Aa lines									
R878H50	C790-15CMS x R778,R778%	8478	32.38	13.06	140	1.9	0.0	88.7	104
8930- 19H50	C790-15CMS x 6930- 19	8569	32.34	13.26	142	0.0	0.0	86.3	110
8930- 39H50	C790-15CMS x 6930- 39	8752	33.97	12.88	143	0.0	0.0	88.8	101
8930-102H50	C790-15CMS x 6930-102	7575	29.32	12.87	138	0.0	0.0	84.9	122

TEST B899. HYBRID PERFORMANCE OF MULTIGERM PROGENY LINES UNDER RHIZOMANIA, IMPERIAL VALLEY, CA., 1998-99

(cont.)

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Bolters	Root Rot[1]	Clean Beets	NO3-N
		Lbs	Tons	%	No.	%	%	%	Mean
Hybrids with C76,*Rz*,MM, S^f,Aa lines									
R876-89-5H50	C790-15CMS x RZM-% R576-89-5	8663	32.24	13.51	154	0.0	0.0	87.2	91
R882H50	C790-15CMS x R781,R776	7334	29.51	12.58	131	0.0	0.0	91.4	151
R882H27	6831-4HO x R781,R776	8282	33.72	12.30	135	2.0	0.0	91.8	105
8929- 41H50	C790-15CMS x 6929- 41	9257	34.05	13.51	157	0.9	0.0	87.3	117
8929- 72H50	C790-15CMS x 6929- 72	8841	33.24	13.29	153	0.0	0.0	90.9	119
8929-102H50	C790-15CMS x 6929-102	8619	34.68	12.39	147	0.0	0.0	93.0	93
8929-112H50	C790-15CMS x 6929-112	9303	34.64	13.47	147	1.9	0.0	90.9	95
8929-114H50	C790-15CMS x 6929-114	8958	30.75	14.52	138	0.0	0.0	89.1	106
8929-115H50	C790-15CMS x 6929-115	9990	38.74	12.90	146	0.0	0.0	90.9	94
8929-133H50	C790-15CMS x 6929-133	7030	25.47	13.80	142	0.0	0.0	79.7	112
8929-153H50	C790-15CMS x 6929-153	8797	33.41	13.19	156	0.0	0.0	89.5	108
8929-154H50	C790-15CMS x 6929-154	6518	28.13	11.68	152	0.0	0.0	82.4	142
Monogerm lines topcrossed to C69									
Y869H50	C790-15CMs x Y769	7508	29.53	12.62	149	1.2	0.0	91.6	134
Y869H27	6831-4HO x Y769	7618	31.07	12.24	152	0.0	0.9	90.3	125
Y869H35	7835mmaa x Y769	6917	28.32	12.17	143	0.0	0.0	92.9	126
Y869H38	7838mmaa x Y769	7624	29.09	13.07	143	0.0	0.0	90.3	116
Y869H17	7817HO x Y769	7754	30.88	12.56	138	0.0	0.0	91.2	112
Y869H9- 1	7808- 1aa x Y769	6833	29.04	11.81	154	0.0	0.0	91.3	98
Y869H9- 2	7808- 2aa x Y769	6011	24.20	12.45	142	0.0	0.0	89.9	106
Y869H9- 3	7808- 3aa x Y769	7379	28.01	13.16	149	0.0	0.0	87.8	90
Y869H9- 4	7808- 4aa x Y769	7273	27.32	13.30	157	0.0	0.0	89.9	88
Y869H9- 7	7808- 7aa x Y769	6741	26.75	12.65	149	0.0	4.4	91.6	109
Y869H9- 8	7808- 8aa x Y769	5756	26.52	10.85	139	0.0	0.0	91.7	132

TEST B899. HYBRID PERFORMANCE OF MULTIGERM PROGENY LINES UNDER RHIZOMANIA, IMPERIAL VALLEY, CA., 1998-99

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Bolters %	Root Rot[1] %	Clean Beets %	NO3-N Mean
Monogerm lines topcrossed to C69 (cont.)									
Y869H9- 9	7808- 9aa x Y769	6336	25.10	12.47	142	0.0	0.0	89.6	102
Y869H9-12	7808-12aa x Y769	7307	30.17	12.07	150	0.0	0.0	88.9	115
Y869H9-13	7808-13aa x Y769	6386	25.10	12.78	142	0.0	0.0	93.8	130
Y869H9-16	7808-16aa x Y769	5858	25.01	11.81	120	0.0	0.0	91.9	118
Y869H15-1B	6818-1Baa x Y769	7186	27.35	13.08	157	0.0	0.0	89.7	127
Y869H15-2B	6818-2Baa x Y769	6789	28.66	11.85	152	0.0	0.0	90.7	118
Y869H15-1	6818-1aa x Y769	6357	24.79	12.76	142	0.0	0.9	92.2	105
Y869H15-2	6818-2aa x Y769	7314	29.16	12.53	152	0.0	0.0	86.9	103
Y869H15-6	6818-6aa x Y769	6782	27.16	12.47	129	0.0	0.0	88.2	113
Y869H15-21	6818-21aa x Y769	5730	22.93	12.60	132	0.0	2.8	89.1	114
Y869H18	7818HO x Y769	7106	29.07	12.19	160	0.0	0.0	88.3	129
Y869H49	7848H88mmaa x Y769	7162	28.48	12.56	156	0.0	0.0	90.4	116
Mean		7705.6	30.36	12.69	146.0	0.4	0.1	88.8	114.1
LSD (.05)		1574.8	5.47	1.16	22.5	2.4	1.5	4.1	42.7
C.V. (%)		14.7	12.92	6.56	11.1	394.9	858.1	3.3	26.9
F value		3.0**	3.05**	2.20**	1.3NS	1.5*	1.4NS	3.4**	1.0NS

NOTES: See Test B699. Test B899 used as screen to identify multigerm lines and progeny with adaptation under rhizomania conditions to Imperial Valley.

[1]Root rot. See Test B499.

TEST B599. AREA 5 CODED RHIZOMANIA YIELD TEST, IMPERIAL VALLEY, CA., 1998-99

32 entries x 8 reps, RCB(E)
1-row plots, 27 ft. long

Planted: October 21, 1998
Harvested: June 10, 1999

Code	Variety	Source	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Clean Beets %	NO3-N Mean
98IVR -21	7CG7321	Betaseed	7845	28.11	13.89	167	91.9	210
-30	Rizor	Spreckels	7590	25.73	14.74	167	94.3	193
- 3	Beta 4430R	Betaseed	7343	25.19	14.52	170	94.9	271
-17	7CG7322	Betaseed	7485	27.82	13.43	168	94.5	228
-29	8CG7064	Betaseed	7052	25.35	13.90	168	94.2	195
-22	Beta 4035R	Betaseed	6179	22.17	13.85	167	93.5	201
-18	SS-NB7R	Spreckels	6227	23.79	13.08	159	94.6	200
- 2	Beta 4776R	Betaseed	5997	21.70	13.78	159	95.2	276
-28	Rifle	Spreckels	5856	19.62	14.88	167	93.9	203
-26	Alpine	Spreckels	6151	23.46	13.07	160	94.2	205
-27	SS-778R	Spreckels	5850	22.58	12.83	164	92.6	240
-24	Beta 4684R	Betaseed	5757	19.90	14.44	162	94.4	214
-16	Phoenix	Spreckels	5679	21.74	12.96	168	94.9	320
-11	97CX01	Spreckels	5630	21.70	13.03	166	93.9	196
- 7	Summit	Spreckels	5741	22.27	12.97	154	93.4	212
-25	7KJ0191	Betaseed	5493	19.12	14.28	163	91.5	228
- 9	SS-781R	Spreckels	5621	22.29	12.57	162	94.5	240
- 5	98HX853	Spreckels	5508	20.93	13.17	160	94.6	218
-12	Beta 4210R	Betaseed	5877	25.46	11.49	162	95.6	374
-10	Pinnacle	Spreckels	5429	20.91	12.99	159	94.5	245
- 4	5CG7540	Betaseed	5329	21.39	12.52	165	92.9	317
-20	Rival	Spreckels	4686	17.21	13.64	156	92.8	196
-19	Imperial	Spreckels	4855	18.90	12.78	154	94.6	250

TEST B599. AREA 5 CODED RHIZOMANIA YIELD TEST, IMPERIAL VALLEY, CA., 1998-99

(cont.)

Code	Variety	Source	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Clean Beets %	NO3-N Mean
98IVR -14	Beta 4684	Check	4625	16.61	13.97	160	93.1	201
- 8	US H11	Standard	4392	17.64	12.39	133	92.4	234
- 6	7CG7400	Betaseed	4146	15.55	13.06	162	90.2	271
-13	SS-IV2	Check	3993	16.37	12.25	167	92.4	204
USDA entries								
8926H50	C790-15CMS x RZM 7926		6656	25.10	13.21	156	93.2	208
Y875H50	C790-15CMS x RZM Y775		6012	22.67	13.25	164	94.1	224
Y875H27	C831-4HO x RZM Y775		5748	22.13	13.03	153	93.2	190
8926H37	4807HO (C306/2CMS) x RZM 7926		5607	24.38	11.52	153	93.4	249
Y875H37	4807HO (C306/2CMS) x RZM Y775		5525	22.41	12.24	160	93.2	246
Mean			5808.9	21.88	13.24	161.1	93.6	233.0
LSD (.05)			1114.8	11.89	0.61	11.4	1.6	46.2
C.V. (%)			19.5	18.89	4.68	7.2	1.8	20.1
F value			5.6**	4.76**	14.64**	3.0**	4.0**	6.5**

TEST B599. AREA 5 CODED RHIZOMANIA YIELD TEST, IMPERIAL VALLEY, CA., 1998-99

(cont.)

Code	Variety	Recover. Sugar lbs/a	Recover. Sugar lbs/t	Recover. Sugar %	Known SugarLoss lbs/a	Sodium ppm	Potassium ppm	NH_2-N ppm	Impur. Value
98IVR -21	7CG7321	6578	232	83.6	1267	997	2493	566	15103
-30	Rizor	6551	254	86.0	1039	695	2339	568	13673
- 3	Beta 4430R	6393	253	87.2	950	837	2133	439	12432
-17	7CG7322	6311	227	84.4	1174	881	2395	512	13936
-29	8CG7064	6229	244	87.8	823	707	1905	426	11283
-22	Beta 4035R	5248	235	84.7	931	900	2375	519	14018
-18	SS-NB7R	5187	217	83.0	1039	806	2532	597	14825
- 2	Beta 4776R	5099	235	85.0	898	962	2147	524	13715
-28	Rifle	5097	259	87.1	759	657	2223	523	12827
-26	Alpine	4992	207	79.2	1159	768	2612	957	18307
-27	SS-778R	4957	216	84.1	892	899	2369	457	13405
-24	Beta 4684R	4939	247	85.5	817	954	2250	530	13997
-16	Phoenix	4825	219	84.2	854	905	2361	469	13527
-11	97CX01	4816	223	85.4	813	825	2112	457	12505
- 7	Summit	4811	217	83.7	930	808	2577	497	13998
-25	7KJ0191	4719	243	84.8	774	875	2439	523	14128
- 9	SS-781	4686	209	82.7	935	913	2372	544	14295
- 5	98HX853	4683	224	84.9	824	798	2257	510	13282
-12	Beta 4210R	4666	182	78.9	1211	1150	2579	571	15890
-10	Pinnacle	4578	219	84.1	851	1056	2259	461	13723
- 4	5CG7540	4369	206	81.8	960	1166	2301	535	14922
-20	Rival	4105	239	87.6	582	725	2075	382	11350
-19	Imperial	4079	214	83.6	776	1025	2240	504	13971

TEST B599. AREA 5 CODED RHIZOMANIA YIELD TEST, IMPERIAL VALLEY, CA., 1998-99

(cont.)

Code	Variety	Recover. Sugar lbs/a	Recover. Sugar lbs/t	Recover. Sugar %	Known SugarLoss lbs/a	Sodium ppm	Potassium ppm	NH_2-N ppm	Impur. Value
98IVR -14	Beta 4684	3944	238	85.1	680	876	2197	554	13820
- 8	US H11	3734	209	84.4	659	784	2134	493	12765
- 6	7CG7400	3468	217	83.1	678	1016	2354	554	14706
-13	SS-IV2	3230	199	81.2	762	1086	2462	548	15163
USDA entries									
8926H50		5633	223	84.3	1023	748	2471	514	13676
Y875H50		5059	223	84.0	953	865	2314	557	14105
Y875H27		4880	221	84.6	869	775	2410	471	13209
8926H37		4862	185	80.3	1172	983	2945	537	15910
Y875H37		4506	199	80.9	1019	1021	2637	551	15400
Mean		4913.6	222.9	84.0	908.6	889.5	2352.3	526.5	13995.8
LSD (.05)		1023.2	16.7	3.7	238.1	281.3	417.9	228.5	3014.8
C.V. (%)		21.1	7.6	4.5	26.6	32.1	18.0	44.1	21.9
F value		5.2**	9.9**	2.7**	3.9**	1.7NS	1.8NS	1.3NS	1.6NS

NOTES: Test was under high nitrogen status. Due to initial emergence and stand problems, test was replanted on October 21, 1998. Up to mid-May, test appeared uniform. At harvest, some plots (e.g., entries 8,13 & 14) were collapsing and test was not uniform in appearance. It appeared that rhizomania and other soil-borne problems were moderate but variable across the field.

USDA entries Y775 and 7926 segregate for resistance to rhizomania from *Beta vulgaris* ssp. *maritima* thru C50 (R22).

TEST B1099. EVALUATION OF TESTCROSS HYBRIDS FOR RESISTANCE TO RHIZOMANIA UNDER HIGH TEMPERATURES, IMPERIAL VALLEY, CA., 1998-99

32 entries x 4 replications, sequential
1-row plots, 13 1/2 ft. long

Planted: September 24, 1998
Not harvested for yield

Variety	Description	Stand Count	% Bolting	Appearance Score			Living Plants
		No.	06/11	05/13	06/11	07/08	%
Checks							
B4776R	Betaseed 4776R.7653 (3-27-98)	20.3	3.4	3.3	2.8	2.8	59.6
US H11	1997	17.0	0.0	3.5	3.5	4.3	16.8
Rifle	Spreckels, 9-98, L1162401	19.8	0.0	3.5	3.0	3.0	58.2
R522(Sp)	RZM-%S R322R4,…(C51)	20.3	14.1	1.8	1.5	1.0	73.1
Topcrossed to C69							
Y869H38	7838aa x Y769	20.0	0.0	4.0	3.5	4.5	16.1
Y869H27	6831-4HO x Y769	18.8	0.0	3.3	3.8	4.0	24.1
Y869H19	7818H50 x Y769	18.8	0.0	3.5	3.3	3.8	27.9
Y869H18	7818HO x Y769	20.8	0.0	3.3	3.3	3.8	26.3
Y869H20	7818-4H50 x Y769	17.8	0.0	3.8	3.5	4.5	10.4
Y869H21	7818-14H50 x Y769	20.3	0.0	3.3	3.8	4.0	18.7
Y869H22	7818-22H50 x Y769	18.3	0.0	3.8	3.8	4.3	17.7
Y869H23	7818-23H50 x Y769	19.8	0.0	3.5	3.3	4.3	19.1
Y869H15-1B	6818-1Baa x Y769	18.5	0.0	3.3	3.8	4.3	16.4
Y869H15-2B	6818-2Baa x Y769	18.3	0.0	3.3	3.8	4.5	10.6
Y869H15-1	6818-1aa x Y769	15.0	0.0	4.3	3.8	4.8	7.3
Y869H15-2	6818-2aa x Y769	15.5	0.0	3.5	3.8	4.0	17.7
Y869H15-6	6818-6aa x Y769	19.5	0.0	4.0	3.8	4.8	4.5
Y869H15-21	6818-21aa x Y769	12.0	0.0	4.0	3.8	4.8	6.3
Y869H9-1	7808-1aa x Y769	19.5	0.0	3.5	3.5	4.3	13.0
Y869H9-2	7808-2aa x Y769	20.3	0.0	4.3	4.3	4.8	5.3
Y869H9-3	7808-3aa x Y769	18.8	0.0	3.5	2.8	3.8	36.9
Y869H9-4	7808-4aa x Y769	18.5	0.0	3.8	3.5	4.0	29.2
Y869H9-7	7808-7aa x Y769	19.0	0.0	3.8	3.8	4.3	16.3
Y869H9-8	7808-8aa x Y769	17.8	0.0	3.8	3.8	4.3	10.1

TEST B1099. EVALUATION OF TESTCROSS HYBRIDS FOR RESISTANCE TO RHIZOMANIA UNDER HIGH TEMPERATURES, IMPERIAL VALLEY, CA., 1998-99

(cont.)

Variety	Description	Stand Count No.	% Bolting 06/11	Appearance Score 05/13	Appearance Score 06/11	Appearance Score 07/08	Living Plants %
Topcrossed to C69 (cont.)							
Y869H9-9	7808-9aa x Y769	16.5	0.0	3.5	3.5	3.8	28.3
Y869H9-12	7808-12aa x Y769	20.3	0.0	3.3	3.3	4.0	30.8
Y869H9-13	7808-13aa x Y769	18.0	0.0	4.0	3.3	3.8	22.6
Y869H9-16	7808-16aa x Y769	14.3	0.0	4.0	3.8	4.3	10.9
Testcrosses to Y75 and popn-926							
Y875H27	6831-4HO x RZM Y775,…	17.5	0.0	2.5	3.0	3.8	33.8
Y875H50	C790-15CMS x RZM Y775,…	18.5	0.0	2.3	2.3	2.5	52.3
8926H50	C790-15CMS x RZM 7926	19.8	0.0	2.3	2.3	3.0	39.3
Y872H50	C790-15CMS x RZM-% Y872	18.3	0.0	1.8	1.8	2.3	77.2
Mean		18.3	0.5	3.4	3.3	3.9	26.2
LSD (.05)		3.0	3.4	0.8	0.7	0.8	18.3
C.V. (%)		11.8	437.8	16.7	15.8	13.9	49.8
F value		3.3**	4.5**	5.3**	5.8**	9.5**	8.7**

NOTES:
Appearance scored on a scale of 1 to 5 where: 1 = very good canopy; 2 = good canopy and appearance often segregating; 3 = intermediate and variable; 4 = fair; and 5 = poor to mostly dead plants.

Appearance scored relative to the overall test at time and based upon canopy size, uniformity, color, vigor, number of dead leaves, and dead plants. The assumption was that plant health and appearance was mostly being influenced by reaction to rhizomania and rhizomania under high temperature conditions. However, other factors such as plant vigor, cyst nematode infection, root rots, etc. could have influenced appearance.

Coefficients of correlation for % Living plants vs. Appearance scores for 5/13, 6/11, & 7/8 and Stand Counts (October 98) are r = -.55**, -.75**, -.90**, and .21*, respectively. Stand counts made post thinning in October 98 and living plants counted 08 July 1999.

TEST B1199. EVALUATION OF MULTIGERM LINES FOR RESISTANCE TO RHIZOMANIA UNDER HIGH TEMPERATURES, IMPERIAL VALLEY, 1998-99

64 entries x 4 replications, sequential
1-row plots, 13 1/2 ft. long

Planted: September 24, 1998
Not harvested for yield

Variety	Description	Stand Count	% Bolting	Appearance Score			Living Plants
		No.	06/11	05/13	06/11	07/08	%
Checks							
US H11	1997	15.3	0.0	4.0	4.0	4.3	11.5
R522 (Sp)	RZM-%S R322R4,… (C51)	19.3	20.9	1.8	1.3	1.0	71.3
B4776R	Betaseed 4776R.7653 (3-27-98)	18.3	0.0	3.5	2.5	2.5	67.4
Rifle	Spreckels, 9-98, L1162401	19.3	0.0	4.0	3.0	2.8	46.7
Rizor	Holly HH108, 9-3-97	19.3	0.0	3.3	3.0	3.0	52.9
SS-778R	Spreckels, 9-98, X782402	19.5	0.0	3.3	3.3	3.0	37.3
Y875 (Iso)	RZM Y775	22.0	2.3	2.0	2.0	2.0	42.5
8926 (Iso)	RZM 7926	18.8	0.0	3.3	3.0	3.5	29.4
MM, O.P. lines							
Y869 (Iso)	RZM Y769 (C69)	18.3	0.0	3.3	3.3	4.0	20.5
R878%	RZM R778% (C78)	18.3	0.0	3.3	3.0	3.3	40.8
R880	RZM R780 (C80)	20.3	0.0	3.0	2.8	3.3	38.3
R881	RZM R776, R781,… (C82)	16.0	0.0	3.0	3.0	3.8	32.8
R882	Inc. R781,R776,… (C82)	18.3	0.0	3.5	3.3	3.5	23.2
Y868	RZM Y768	20.3	0.0	3.3	3.0	3.5	39.4
R876-89-5NB	RZM-% R576-89-5NB, (C76-89-5)	19.3	0.0	3.0	3.3	4.3	13.4
Y875 (Sp)	RZM Y775,Y773,Y772,…	18.8	1.5	2.3	2.5	2.8	33.8
98-EL-02	RZM EL#s (C80*Rz* x SR)	19.0	1.5	3.0	2.8	3.3	37.8
98-EL-04	RZM EL#s (C80*Rz* x SR)	20.5	1.1	3.0	2.8	3.0	41.7
R824	RZM R724 (C79-2), R725 (C79-3)	19.8	0.0	3.5	3.3	4.3	12.1
R835	RZM R735 (C79-7,SES)	17.3	0.0	2.8	3.0	3.8	38.8

TEST B1199. EVALUATION OF MULTIGERM LINES FOR RESISTANCE TO RHIZOMANIA UNDER HIGH TEMPERATURES, IMPERIAL VALLEY, 1998-99

(cont.)

Variety	Description	Stand Count	% Bolting	Appearance Score			Living Plants
		No.	06/11	05/13	06/11	07/08	%
MM, O.P. lines (cont.)							
97-C37	Inc. U86-37	17.5	0.0	4.3	4.0	4.5	7.2
R879	RZM R779 (C79-1,*Rz*)	17.3	0.0	4.8	4.5	4.5	8.9
R836	RZM R736 (C79-8,R22)	21.3	6.2	2.3	2.5	2.8	29.0
US H11	1997	15.8	0.0	4.3	4.0	4.3	14.2
R746 (Iso)	RZM R646	18.0	0.0	3.3	3.3	3.8	26.4
R853	RZM-ER-% R653	20.3	0.0	4.0	3.5	4.3	9.0
R854	RZM R754	19.0	0.0	3.8	3.8	4.5	9.5
Y873	RZM-ER-% Y673	17.8	0.0	2.0	2.0	3.0	39.8
Y873B	RZM Y773	20.0	0.0	2.5	2.8	3.5	32.3
97-C37	Inc. U86-37	20.3	0.0	4.8	4.5	4.5	6.3
R840	RZM R740 (C79-#s)	21.5	1.1	2.3	3.0	3.3	32.7
Y866	RZM Y766	20.3	1.1	1.8	1.5	2.0	42.4
Y867	RZM Y767 (C67)	19.0	0.0	2.5	2.3	2.0	59.0
Y871	RZM Y771	19.8	1.0	2.5	2.0	2.8	34.5
Y872	RZM-% Y672	19.8	0.0	3.0	2.5	3.0	33.3
Y872B	RZM Y772 (C72)	19.8	1.1	2.8	2.8	3.3	29.7
Y875 (Iso)	RZM Y775	18.8	1.5	2.5	2.5	3.3	32.2
8810M	RZM 7810NB (C890-#s)	18.0	0.0	3.8	3.3	3.8	23.6
R826	RZM R726 (C26)	19.3	10.1	2.5	2.5	3.3	25.7
R827	RZMR727A,B (C27)	20.5	1.1	3.0	3.0	3.5	27.3

TEST B1199. EVALUATION OF MULTIGERM LINES FOR RESISTANCE TO RHIZOMANIA UNDER HIGH TEMPERATURES, IMPERIAL VALLEY, 1998-99

(cont.)

Variety	Description	Stand Count	% Bolting	Appearance Score			Living Plants
		No.	06/11	05/13	06/11	07/08	%
MM, O.P. lines (cont.)							
P811	RZM-PMR 6203,6208(C),(R79 x P03,P04)	18.8	10.9	3.0	2.5	2.5	38.3
P812	RZM-PMR 6211,6217(C),(C918 x P02)	19.3	3.6	1.0	1.5	2.0	51.1
P813	Inc. 6201,6202(C),(C37 x P03),CP01	19.0	0.0	4.8	4.3	4.8	1.3
P814	Inc. 6205,6206(C),(C37 x P04),CP02	16.8	0.0	4.0	4.0	4.5	7.2
MM,S^f,Aa populations							
N724	Inc. N623,N624 (galls),SBCN resist.	17.3	0.0	3.0	3.0	4.0	18.5
CR811	RZM CR711 (CR09/10)	18.3	0.0	3.0	3.3	3.8	25.7
CR812	RZM CR712 (931 x CR11)	22.8	0.0	3.0	3.3	3.8	27.7
CR813	RZM CR713 (932CT x CR11)	17.3	0.0	3.0	3.8	4.3	20.8
7747	Inc. 5747 (A,aa)	14.0	0.0	4.3	4.0	4.8	3.1
8931	RZM 7931aa x A	18.5	0.0	3.5	3.8	4.5	9.4
8927	RZM 7926aa x A	17.3	3.1	2.3	2.3	2.8	39.4
8926 (Sp)	7931aa x RZM 7926	20.0	0.0	2.5	2.8	2.8	36.1
8927-29	Inc. 6927-29 (A,aa),(5921H18),Inc. S_1	15.0	0.0	5.0	4.5	5.0	0.0
8927-30	Inc. 6927-30 (A,aa),(5921H18),Inc. S_1	16.0	0.0	1.8	1.3	1.8	70.9
8927-33	Inc. 6927-33 (A,aa),(5921H18),Inc. S_1	18.8	0.0	2.5	2.5	3.0	32.3
8927-37	Inc. 6927-37 (A,aa),(5921H18),Inc. S_1	16.0	0.0	4.0	4.8	4.8	2.6
8924	RZM 7924aa x A	20.3	0.0	3.3	3.8	4.0	11.2
8932	7932CT,7201-7215aa x A, R_z-CTR	15.5	0.0	3.5	4.3	4.8	3.6
Z831	RZM Z731,Z730aa x A	17.8	0.0	3.0	3.8	4.3	12.5
8935 (Iso)	RZM R776-89-5H13	17.8	0.0	3.8	3.8	4.3	11.1

TEST B1199. EVALUATION OF MULTIGERM LINES FOR RESISTANCE TO RHIZOMANIA UNDER HIGH TEMPERATURES, IMPERIAL VALLEY, 1998-99

(cont.)

Variety	Description	Stand Count	% Bolting	Appearance Score			Living Plants
		No.	06/11	05/13	06/11	07/08	%
MM,S^f,Aa populations (cont.)							
8936	RZM R776-89-5H31	19.3	0.0	3.3	3.0	4.8	4.7
8937	RZM R776-89-5H11	19.5	0.0	3.0	3.3	4.0	14.5
8938	RZM Z731H11	21.0	0.0	3.5	3.5	4.0	19.4
8939	RZM Y769H31	17.0	0.0	3.8	3.5	4.0	19.2
Mean		18.6	1.1	3.1	3.1	3.5	27.1
LSD (.05)		3.6	3.6	0.8	0.8	0.9	19.1
C.V. (%)		14.0	242.8	18.4	19.2	18.1	50.5
F value		1.8**	6.3**	7.7**	7.1**	7.4**	6.3**

See notes for B1299.

Coefficients of correlation for % Living vs. Appearance scores for 5/13, 6/11 & 7/8 and Stand Counts (October 1998) are r = -.52**,-.74**,-.88**, and .03, respectively. Stand counts made post thinning in October. Living plants counted 08 July 1999. The highest level of survival and best appearance in late season again appeared to be associated with resistance to rhizomania from *Beta maritima* thru R22 (C50 & C51), e.g., lines R522, C67, & 8927-30. Although CP01 and CP02 that segregated for powdery mildew resistance from WB97 and WB242 are highly rhizomania susceptible, when crossed to *Rz*, give a higher than expected level of resistance to rhizomania (see P811 and P814 in this test and full-sib lines P807B and P808B in test B1299).

TEST B1299. EVALUATION OF PAIR CROSSES (FULL SIB) FOR RESISTANCE TO RHIZOMANIA UNDER HIGH TEMPERATURES, IMPERIAL VALLEY, 1998-99

128 entries x 2 reps., sequential
1-row plots, 13 1/2 ft. long

Planted: September 24, 1998
Not harvested for yield

Variety	Description	Stand Count	% Bolting	Appearance Score			Living Plants
		No.	06/10	05/12	06/11	07/08	%
Checks							
Rifle	Spreckels, 9-98, L1162401	16.5	0.0	3.0	3.0	3.5	41.1
SS-778R	Spreckels, 9-98, X782402	17.5	0.0	3.0	3.5	3.0	37.9
B4776R	Betaseed 4776R.7653 (3-27-98)	22.5	0.0	3.0	2.5	3.0	60.1
US H11	1997	16.0	0.0	4.0	4.5	4.5	21.9
R522 (Sp)	RZM-%S R322R4,…(C51)	17.5	25.8	2.0	1.5	1.0	68.8
8926 (Iso)	RZM 7926	25.5	0.0	3.0	2.5	3.5	25.0
97-C37	Inc. U86-37	21.0	0.0	4.5	5.0	5.0	0.0
Y875 (Iso)	RZM Y775	14.5	0.0	2.5	2.5	3.0	30.2
R846-# = RZM R746PX = C37*3 x R22 (gh 5)							
R846 - 1	RZM R746PX	15.5	0.0	3.0	3.0	4.0	52.7
- 2		18.0	0.0	2.5	3.0	3.5	38.1
- 3		18.5	0.0	3.0	3.5	3.5	40.9
- 4		18.5	0.0	3.0	3.5	4.5	13.6
- 5		15.5	0.0	1.5	2.0	2.0	47.0
- 6		17.0	0.0	1.5	2.0	2.0	61.8
- 7		19.0	0.0	2.0	2.5	3.5	19.6
- 8		14.0	0.0	2.0	2.5	3.5	31.5
R853-# = RZM R753PX = C37*4 x R22 (gh 5)							
R853 - 1	RZM R753PX	16.0	0.0	3.0	3.5	4.5	8.3
- 2		16.0	0.0	3.5	4.0	3.5	31.3
- 3		22.5	0.0	2.5	2.5	3.0	38.0
- 4		21.0	0.0	2.5	3.0	4.0	14.3
- 5		17.5	0.0	3.5	3.0	3.5	36.7
- 6		24.0	0.0	2.5	2.5	3.0	40.6
- 7		22.0	0.0	3.5	4.0	4.0	15.9
- 8		14.5	0.0	3.5	3.5	4.5	14.3

TEST B1299. EVALUATION OF PAIR CROSSES (FULL SIB) FOR RESISTANCE TO RHIZOMANIA UNDER HIGH TEMPERATURES, IMPERIAL VALLEY, 1998-99

(cont.)

Variety	Description	Stand Count No.	% Bolting 06/10	Appearance Score 05/12	Appearance Score 06/11	Appearance Score 07/08	Living Plants %
R853-# = RZM R753PX = C37*4 x R22 (gh 5) (cont.)							
R853 - 9	RZM R753PX	17.5	0.0	2.5	2.5	3.5	50.8
-10		16.0	0.0	4.0	4.0	4.0	15.1
-11		20.0	0.0	3.0	3.0	3.5	30.0
-12		20.5	0.0	2.5	3.0	4.0	12.4
-13		14.0	0.0	2.5	3.5	3.5	41.3
-14		19.0	0.0	2.0	2.5	4.5	28.6
-15		18.0	0.0	4.5	4.5	4.5	6.3
-16		13.0	0.0	4.0	3.5	4.0	26.2
-17		16.0	0.0	3.0	3.0	4.0	28.2
-18		13.5	0.0	3.0	2.5	3.5	53.3
-19		20.5	0.0	3.5	3.0	3.5	31.4
-20		18.5	0.0	3.0	3.5	3.5	29.0
-21		12.0	0.0	2.5	2.5	3.5	45.7
-22		12.5	0.0	3.0	4.0	4.5	14.3
Y873-# = RZM Y773PX = F_2(C37 x Y71(C)) (gh 5)							
Y873 - 1	RZM Y773PX	20.5	0.0	4.5	5.0	5.0	0.0
- 2		18.0	0.0	1.5	2.5	3.5	34.1
- 3		15.0	0.0	2.5	3.0	3.0	43.3
- 4		18.5	0.0	4.0	4.0	4.0	26.9
- 5		20.0	0.0	1.5	1.5	2.0	53.5
- 6		16.0	0.0	3.0	3.0	4.0	23.3
- 7		17.5	0.0	3.0	2.5	4.0	34.2
- 8		20.5	0.0	4.0	4.5	4.5	7.5
- 9		20.5	0.0	1.0	1.0	1.5	53.9
-10		17.0	0.0	2.0	2.0	3.5	28.8

TEST B1299. EVALUATION OF PAIR CROSSES (FULL SIB) FOR RESISTANCE TO RHIZOMANIA UNDER HIGH TEMPERATURES, IMPERIAL VALLEY, 1998-99

(cont.)

Variety	Description	Stand Count No.	% Bolting 06/10	Appearance Score 05/12	Appearance Score 06/11	Appearance Score 07/08	Living Plants %
Y873-# = RZM Y773PX = F_2(C37 x Y71(C)) (gh 5) (cont.)							
Y873 -11	RZM Y773PX	16.0	0.0	1.5	1.5	4.0	23.5
-12		13.5	0.0	5.0	5.0	4.5	7.1
-13		20.5	0.0	1.5	1.5	3.0	49.4
-14		17.5	0.0	2.0	1.5	2.5	40.8
-15		17.5	0.0	2.0	1.5	2.5	27.8
-16		8.5	0.0	2.5	2.5	3.0	36.1
-17		1.5	0.0	3.0	3.5	4.0	50.0
-18		13.0	0.0	2.0	1.5	3.0	56.0
-19		14.5	3.3	3.0	3.0	4.0	13.8
-20		13.5	4.5	3.5	3.0	3.5	24.4
Checks							
US H11	1997	15.5	0.0	4.0	4.0	4.0	13.3
Y875 (Sp)	RZM Y775,Y773,…	19.0	0.0	2.5	2.5	3.0	28.9
Y867-# = RZM Y767PX = Y31 x (O.P. x R22) (gh 5)							
Y867 - 1	RZM Y767PX	14.0	0.0	1.5	1.5	1.5	61.3
- 2		18.5	3.8	1.5	1.0	1.0	63.5
- 3		18.5	0.0	1.5	1.0	1.0	64.9
- 4		16.0	0.0	3.0	2.5	3.5	31.8
- 5		15.5	0.0	4.0	3.5	4.0	21.9
- 6		16.5	0.0	3.0	2.0	2.5	65.0
- 7		18.5	0.0	2.0	1.5	2.0	53.8
- 8		17.5	0.0	3.0	2.5	2.5	60.7
- 9		19.0	0.0	2.5	2.0	2.0	66.2
-10		18.5	0.0	3.0	3.0	3.5	37.1
-11		16.5	0.0	3.5	3.0	3.0	53.9

TEST B1299. EVALUATION OF PAIR CROSSES (FULL SIB) FOR RESISTANCE TO RHIZOMANIA UNDER HIGH TEMPERATURES, IMPERIAL VALLEY, 1998-99

(cont.)

Variety	Description	Stand Count No.	% Bolting 06/10	Appearance Score 05/12	Appearance Score 06/11	Appearance Score 07/08	Living Plants %
Y871-# = RZM Y771PX = O.P. x R22 (gh 5)							
Y871 - 1	RZM Y771PX	18.5	0.0	2.0	1.5	1.5	67.4
- 2		16.5	0.0	2.5	2.0	4.0	25.0
- 3		17.5	0.0	2.0	2.0	3.5	43.3
- 4		19.5	0.0	2.0	1.5	1.5	50.4
- 5		18.5	2.5	1.5	1.5	2.0	55.6
- 6		16.5	0.0	2.0	1.5	1.5	68.5
- 7		17.5	15.8	3.0	2.5	3.0	28.3
- 8		18.0	0.0	4.0	3.5	4.0	17.0
- 9		14.5	0.0	2.0	1.5	2.5	45.7
-10		13.0	0.0	4.0	3.0	3.5	30.8
-11		17.5	0.0	2.5	2.0	2.0	60.5
Y872-# = RZM Y772 = R80,R76 x (C37 x R22) (gh 5)							
Y872 - 1	RZM Y772PX	14.5	0.0	1.0	2.0	2.0	34.0
- 2		15.5	0.0	1.0	1.5	1.5	63.9
- 3		12.0	0.0	2.0	2.0	3.0	37.5
- 4		13.0	0.0	1.5	1.5	1.5	64.7
- 5		16.5	0.0	3.5	4.0	4.5	16.7
- 6		16.0	0.0	1.5	1.5	1.5	71.9
- 7		18.0	0.0	2.5	1.5	2.5	41.7
- 8		18.5	0.0	1.5	1.0	2.0	49.1
- 9		17.5	0.0	1.0	1.0	1.0	74.8
-10		15.5	0.0	2.0	1.5	2.0	74.6
Checks							
US H11	1997	16.5	0.0	4.5	3.5	4.5	5.3
8927	RZM 7926aa x A	22.5	2.1	2.0	1.5	2.5	31.8

TEST B1299. EVALUATION OF PAIR CROSSES (FULL SIB) FOR RESISTANCE TO RHIZOMANIA UNDER HIGH TEMPERATURES, IMPERIAL VALLEY, 1998-99

(cont.)

Variety	Description	Stand Count No.	% Bolting 06/10	Appearance Score 05/12	Appearance Score 06/11	Appearance Score 07/08	Living Plants %
8934-# = R776-89-5NB x RZM 7934-# (C913-70aa x R636)							
8934 - 1	R776-89-5NB x RZM 7934-#	15.5	0.0	2.0	1.0	3.5	40.8
- 2		15.5	3.1	2.0	1.0	2.5	42.1
- 3		17.5	0.0	3.0	2.5	3.0	29.3
- 4		14.5	0.0	2.5	2.0	4.5	5.6
- 5		19.0	0.0	2.0	1.0	1.5	74.4
- 6		18.0	0.0	3.0	2.0	2.5	47.2
8926-# = RZM 7926⊗ = MM,S^f,Aa,R22 (gh 4)							
8926 - 1	RZM 7926⊗, S_1 progenies	14.5	0.0	2.0	1.5	2.5	72.9
- 2		18.0	0.0	2.0	2.0	3.0	43.3
- 3		16.5	0.0	4.0	4.0	4.0	18.4
- 4		10.0	0.0	3.1	3.0	3.0	60.0
- 5		13.5	0.0	4.5	4.0	5.0	0.0
- 6		14.0	0.0	3.5	4.0	5.0	0.0
- 7		18.0	0.0	3.0	3.5	4.0	11.3
- 8		16.5	0.0	3.5	4.5	5.0	0.0
- 9		12.0	0.0	4.0	4.0	5.0	0.0
-10		16.5	0.0	3.0	4.0	4.5	5.9
-11		14.0	0.0	3.5	3.5	4.0	14.6
-12		11.0	0.0	3.5	3.0	4.0	22.5
-13		13.5	0.0	2.5	2.5	3.5	41.2
-14		15.0	20.0	2.0	3.0	5.0	0.0
-15		16.0	0.0	5.0	5.0	5.0	0.0
-16		15.0	0.0	2.5	2.5	2.5	62.9
P807B-# = R778% x RZM P707B ((Y71 x P603)(~CP01)) (gh 10)							
P807B - 2	RZM P707B x R778%	21.0	0.0	1.0	1.0	1.0	74.1
- 4		20.5	0.0	2.5	2.5	2.5	61.6
- 5		16.5	0.0	3.0	2.5	2.5	55.6
- 8		18.0	0.0	2.0	1.0	1.5	66.6

TEST B1299. EVALUATION OF PAIR CROSSES (FULL SIB) FOR RESISTANCE TO RHIZOMANIA UNDER HIGH TEMPERATURES, IMPERIAL VALLEY, 1998-99

(cont.)

Variety	Description	Stand Count No.	% Bolting 06/10	Appearance Score 05/12	Appearance Score 06/11	Appearance Score 07/08	Living Plants %
P808B-# = R778% x RZM P708B ((Y71 x P604)(~CP02)) (gh 10)							
P808B- 2	RZM P708B x R778%	11.5	0.0	1.5	1.5	2.5	63.1
- 3		18.5	0.0	4.0	4.0	4.0	5.4
- 4		18.0	0.0	3.5	3.0	3.5	30.5
- 7		18.5	0.0	1.0	1.5	1.5	56.9
Checks							
Y867	RZM Y767 (C67)	18.5	0.0	1.5	1.0	1.0	73.1
Y872	RZM-%S Y672 (C72)	18.0	0.0	1.5	1.0	1.5	67.6
US H11	1997	13.5	0.0	4.5	5.0	5.0	0.0
R522 (Sp)	RZM-%S R322R	17.0	14.7	1.5	1.0	1.0	82.4
Mean		16.7	0.7	2.7	2.6	3.2	37.1
LSD (.05)		4.9	5.1	1.3	1.2	1.4	32.8
C.V. (%)		14.8	345.4	24.3	23.9	22.8	44.7
F value		3.2**	3.6**	4.3**	6.0**	4.7**	3.5**

NOTES:

Appearance scored on a scale of 1 to 5 where: 1 = very good canopy; 2 = good canopy and appearance often segregating; 3 = intermediate and variable; 4 = fair; and 5 = poor to mostly dead plants.

Appearance scored relative to the overall test at time and based upon canopy size, uniformity, color, vigor, number of dead leaves, and dead plants. The assumption was that plant health and appearance was mostly being influenced by reaction to rhizomania and rhizomania under high temperature conditions. However, other factors such as plant vigor, cyst nematode infection, root rots, etc. could have influenced appearance.

Coefficients of correlation for % Living plants vs. Appearance scores for 5/12,6/11, & 7/8 and Stand Counts (October 1998) are r = -.60**, -.72**, -.87**, and 0.01, respectively. Stand counts made post thinning in October. Living plants counted 08 July 1999.

TEST B1399. EVALUATION OF MONOGERM S_1 PROGENY FOR RESISTANCE TO RHIZOMANIA UNDER HIGH TEMPERATURES, IMPERIAL VALLEY, 1998-99

138 entries x 1 or 2 replications, sequential
1-row plots, 13 1/2 ft. long

Planted: September 24, 1998
Not harvested for yield

Variety	Description	Stand Count	Appearance Score			Living Plants
		No.	05/12	06/10	07/08	%
Checks						
8835	7835mmaa x A	20.0	3.0	2.5	3.5	22.9
8838	7838mmaa x A	17.5	4.0	3.5	4.0	5.8
8848M	RZM 7848 (=C790 x 848)	21.0	2.5	2.5	3.0	26.1
8810M	RZM 7810NB	20.0	2.5	3.0	3.5	32.5
8818-1B	Inc. 6818B-1	19.5	3.0	2.5	4.0	10.4
8818-2B	Inc. 6818B-2	15.0	4.0	4.0	4.5	2.9
Increase of 6818-# S_1's = C790 x R22 = C790-8						
8818- 1(C)	Inc. 6818- 1mm (A,aa)	9.5	4.5	4.0	4.5	7.1
8818- 2(C)	Inc. 6818- 2mm (A,aa)	10.5	3.5	4.5	5.0	0.0
8818- 6(C)	Inc. 6818- 6mm (A,aa)	17.5	2.5	3.5	4.5	8.8
8818-11(C)	Inc. 6818-11mm (A,aa)	9.5	3.0	3.5	4.5	3.6
8818-12(C)	Inc. 6818-12mm (A,aa)	19.0	4.0	3.5	4.5	18.4
8818-21(C)	Inc. 6818-21mm (A,aa)	11.0	3.5	3.5	4.0	11.5
S_1's of popn-818 = C790 x R22 = C790-8						
8818 - 1	RZM-%S 6818mm⊗	18.0	3.5	3.5	3.5	28.1
- 2		14.5	4.0	3.5	4.0	28.6
- 3		17.5	1.0	1.0	2.0	63.3
- 4		17.5	2.5	2.5	4.0	17.3
- 5		17.5	1.5	2.0	2.0	68.5
- 6		17.5	2.0	2.5	3.0	41.0
- 7		15.0	3.0	2.5	3.5	43.3
- 8		14.0	2.0	2.0	2.5	55.4
- 9		18.5	3.0	2.5	4.0	20.4
-10		12.0	3.0	3.0	3.5	45.0
-11		10.0	3.0	3.0	3.0	60.0
-12		8.0	3.0	3.0	5.0	0.0

TEST B1399. EVALUATION OF MONOGERM S_1 PROGENY FOR RESISTANCE TO RHIZOMANIA UNDER HIGH TEMPERATURES, IMPERIAL VALLEY, 1998-99

(cont.)

Variety	Description	Stand Count	Appearance Score			Living Plants
		No.	05/12	06/10	07/08	%
S_1's of popn-808 = C790 x 808(C) = C890-#'s						
8808 - 1	RZM-%S 6808mm⊗	18.5	4.5	3.5	5.0	0.0
- 2		16.0	2.0	2.0	3.0	62.5
- 3		21.0	4.5	3.5	4.0	7.0
- 4		15.0	3.0	3.5	5.0	0.0
- 5		17.0	4.0	3.5	4.5	14.3
- 6		18.5	3.0	4.0	4.5	5.3
8808 - 7	RZM-%S 6808mm⊗	17.0	3.5	3.5	4.5	5.3
- 8		17.5	2.5	2.5	3.5	25.5
- 9		18.0	3.0	3.0	4.0	22.3
-10		20.0	2.5	2.5	4.0	17.4
-11		19.0	3.0	2.5	3.5	37.8
-12		16.5	4.5	4.0	4.5	7.7
8808 -13	RZM-%S 6808mm⊗	14.5	3.5	3.0	4.0	24.3
-14		15.5	3.0	3.0	4.0	20.2
-15		3.5	3.5	3.5	4.5	16.7
-16		13.5	2.5	3.0	4.5	4.2
-17		4.5	3.5	3.5	4.0	0.0
-18		17.5	2.5	2.0	3.0	41.4
8808 -19	RZM-%S 6808mm⊗	55.0	4.0	4.0	4.5	7.1
-20		no plants	-.-	-.-	-.-	-.-
-21		16.0	2.5	2.5	5.0	0.0
-22		12.0	2.5	2.5	5.0	0.0
-23		15.5	3.0	2.5	4.0	12.9
-24		3.0	4.0	3.5	4.5	25.0

TEST B1399. EVALUATION OF MONOGERM S_1 PROGENY FOR RESISTANCE TO RHIZOMANIA UNDER HIGH TEMPERATURES, IMPERIAL VALLEY, 1998-99

(cont.)

Variety	Description	Stand Count	Appearance Score			Living Plants
		No.	05/12	06/10	07/08	%
Checks						
97-C37	Inc. U86-37	15.5	3.0	2.5	4.0	15.3
R879	RZM R779 (C79-1*Rz*)	18.0	3.5	2.0	3.5	41.2
R836	RZM R736 (C70-8*Rz*)	17.5	2.0	1.0	2.0	46.1
9818-1B	Inc. 6818B-1	19.5	3.5	2.0	4.0	15.3
9818-2B	Inc. 6818B-2	18.5	3.0	3.0	4.5	5.3
8810M	RZM 7810NB	17.5	3.0	3.0	4.5	15.0
S_2's from Type-O Indexing (1 rep)						
8808 -2-1	7808-2mm⊗	14.0	4.0	3.0	5.0	0.0
-2-2		13.0	5.0	4.0	5.0	0.0
-2-3		12.0	5.0	4.0	5.0	0.0
-2-4		19.0	4.0	3.0	5.0	0.0
-2-5		13.0	4.0	4.0	5.0	0.0
-2-6		19.0	5.0	4.0	5.0	0.0
-2-7		13.0	5.0	4.0	5.0	0.0
8808 -3-1	7808-3mm⊗	16.0	4.0	3.0	5.0	0.0
-3-2		17.0	4.0	3.0	5.0	0.0
-3-3		15.0	4.0	4.0	5.0	0.0
-3-4		13.0	4.0	3.0	5.0	0.0
-3-5		16.0	4.0	4.0	5.0	0.0
-3-6		10.0	4.0	3.0	4.0	20.0
8808 -4-1	7808-4mm⊗	16.0	4.0	4.0	5.0	0.0
-4-2		14.0	5.0	4.0	5.0	0.0
-4-3		9.0	4.0	5.0	5.0	0.0
-4-4		16.0	4.0	4.0	5.0	0.0
-4-5		21.0	4.0	4.0	5.0	0.0

TEST B1399. EVALUATION OF MONOGERM S_1 PROGENY FOR RESISTANCE TO RHIZOMANIA UNDER HIGH TEMPERATURES, IMPERIAL VALLEY, 1998-99

(cont.)

Variety	Description	Stand Count	Appearance Score			Living Plants
		No.	05/12	06/10	07/08	%
S_2's from Type-O Indexing (1 rep) (cont.)						
8808 -4-6	7808-4mm⊗	13.0	4.0	4.0	5.0	0.0
-4-7		11.0	5.0	4.0	5.0	0.0
8808 -7-1	RZM 6808⊗	13.0	4.0	4.0	5.0	0.0
-7-2		21.0	4.0	3.0	5.0	0.0
-7-4		15.0	3.0	3.0	5.0	0.0
8808 -8-1	7808-8mm⊗	17.0	4.0	3.0	5.0	0.0
-8-2		12.0	5.0	4.0	5.0	0.0
US H11		17.0	2.0	2.0	3.0	29.4
8808 -8-4	7808-8mm⊗	4.0	4.0	4.0	5.0	0.0
-8-5		21.0	4.0	4.0	5.0	0.0
-8-7		12.0	4.0	3.0	5.0	0.0
8808 -9-1	7808-9 18	5.0	3.0	5.0	0.0	
-9-2		5.0	5.0	4.0	5.0	0.0
-9-3		15.0	5.0	4.0	5.0	0.0
-9-4		20.0	5.0	4.0	5.0	0.0
-9-5		18.0	4.0	4.0	5.0	0.0
-9-6		19.0	3.0	4.0	5.0	0.0
-9-7		20.0	4.0	4.0	5.0	0.0
-9-11		14.0	5.0	4.0	5.0	0.0
-9-12		15.0	5.0	4.0	5.0	0.0
8808 -12-1	7808-12mm⊗	19.0	5.0	4.0	5.0	0.0
-12-3		20.0	5.0	4.0	5.0	0.0
-12-4		19.0	4.0	4.0	5.0	0.0
-12-5		18.0	4.0	4.0	5.0	0.0
-12-6		13.0	5.0	4.0	5.0	0.0
-12-7		11.0	5.0	4.0	5.0	0.0

TEST B1399. EVALUATION OF MONOGERM S_1 PROGENY FOR RESISTANCE TO RHIZOMANIA UNDER HIGH TEMPERATURES, IMPERIAL VALLEY, 1998-99

(cont.)

Variety	Description	Stand Count	Appearance Score			Living Plants
		No.	05/12	06/10	07/08	%
S_2's from Type-O Indexing (1 rep) (cont.)						
8808 -13-1	7808-13mm⊗	14.0	2.0	3.0	4.0	21.4
-13-2		18.0	3.0	3.0	5.0	0.0
-13-3		19.0	2.0	3.0	4.0	15.8
-13-4		18.0	3.0	4.0	4.0	5.6
-13-5		10.0	4.0	4.0	5.0	0.0
-13-6		3.0	4.0	3.0	3.0	66.7
8808 -16-1	7808-16mm⊗	10.0	4.0	4.0	5.0	0.0
-16-2		12.0	4.0	4.0	5.0	0.0
-16-3		11.0	4.0	4.0	5.0	0.0
-16-4		14.0	4.0	4.0	5.0	0.0
-16-5		3.0	2.0	4.0	5.0	0.0
-16-6		6.0	2.0	4.0	5.0	0.0
-16-7		12.0	2.0	4.0	5.0	0.0
Checks						
8835	7835mmaa x A	22.0	5.0	2.0	2.0	31.8
8838	7838mmaa x A	22.0	5.0	3.0	4.0	13.6
8848	RZM 7848	19.0	5.0	2.0	1.0	52.6
S_1's from C890-7 (SES)						
8818-5(C)	Inc. 6817mm (A,aa)	13.0	4.0	4.0	4.0	0.0
8817-1	RZM-%S 6817mm⊗	17.0	4.0	3.0	4.0	0.0
8817-2		19.0	3.0	3.0	4.0	21.1
8817-3		16.0	3.0	2.0	3.0	56.3
8817-4		14.0	3.0	3.0	4.0	7.1
8817-5		15.0	3.0	3.0	4.0	20.0

TEST B1399. EVALUATION OF MONOGERM S_1 PROGENY FOR RESISTANCE TO RHIZOMANIA UNDER HIGH TEMPERATURES, IMPERIAL VALLEY, 1998-99

(cont.)

Variety	Description	Stand Count	Appearance Score			Living Plants
		No.	05/12	06/10	07/08	%
S_1's from C890-5 (R04)						
8815 - 1	RZM-%S 6815mm⊗	18.0	3.0	3.0	4.0	11.1
- 2		10.0	5.0	4.0	4.0	20.0
- 3		14.0	4.0	3.0	4.0	28.6
- 4		13.0	5.0	4.0	4.0	7.7
- 5		no plants	-.-	-.-	-.-	-.-
- 6		9.0	3.0	3.0	5.0	0.0
S_1's from C890-9 (WB151)						
8819 - 1	RZM-%S 6819mm⊗	19.0	4.0	4.0	5.0	0.0
- 2		10.0	5.0	4.0	5.0	0.0
- 3		20.0	2.0	2.0	5.0	0.0
- 4		18.0	3.0	4.0	5.0	0.0
S_1's from C890-10 (WB169)						
8820 - 1	RZM-%S 6820mm⊗	19.0	2.0	3.0	5.0	0.0
- 2		12.0	5.0	4.0	5.0	0.0
- 3		14.0	3.0	4.0	4.0	7.1
- 4		23.0	3.0	3.0	4.0	8.7
S_1's from C890-11 (WB258)						
8821 - 1	RZM-%S 6821mm⊗	19.0	3.0	4.0	5.0	0.0
- 2		19.0	2.0	4.0	5.0	0.0
- 3		20.0	3.0	3.0	5.0	0.0
- 4		16.0	4.0	4.0	4.0	12.5

See notes for tests B1199 and B1299.

TEST B1499. EVALUATION OF HERBICIDE TRANSGENIC HYBRIDS FOR YIELD, IMPERIAL VALLEY, CA., 1998-99

6 entries x 8 reps., RCB
4-row plots, 24 + 3 ft. long

Planted: October 23, 1998
Harvested: June 13, 1999

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Root Rot	Clean Beets	NO3-N
		Lbs	Tons	%	No.	%	%	Mean
Checks								
Rifle	Spreckels, 9-98, L1162401	7843	25.50	15.35	158	0.0	94.2	125
B4776R	Betaseed 4776R.7653 (3-27-98)	7597	24.94	15.21	147	0.0	95.3	128
Roundup-ready								
HM 115RR	Hilleshog Round-up ready	8784	30.06	14.63	157	0.0	95.4	64
HM 117RR	Hilleshog Round-up ready	7055	25.01	14.11	122	0.2	93.1	67
HM 116RR	Hilleshog Round-up ready	6348	23.91	13.29	150	0.5	93.1	81
Liberty-link								
8CG9372LL	Betaseed Liberty-link	7609	23.76	16.02	168	0.0	94.5	95
Mean		7539.4	25.53	14.77	150.3	0.1	94.3	93.4
LSD (.05)		501.9	1.30	0.55	10.9	0.3	1.1	25.8
C.V. (%)		6.6	5.03	3.65	7.2	301.2	1.2	27.2
F value		21.6**	26.06**	25.97**	16.7**	2.6*	6.7**	9.9**

TEST B1499. EVALUATION OF HERBICIDE TRANSGENIC HYBRIDS FOR YIELD, IMPERIAL VALLEY, CA., 1998-99

(cont.)

Variety	Recover. Sugar lbs/a	Recover. Sugar lbs/t	Recover. Sugar %	Known SugarLoss lbs/a	Sodium ppm	Potassium ppm	NH_2-N ppm	Impur. Value
Checks								
Rifle	6877	269	87.6	966	286	2599	546	12686
B4776R	6638	265	87.2	959	330	2317	625	12881
Roundup-ready								
HM 115RR	7662	255	87.1	1122	258	2432	585	12543
HM 117RR	6157	246	87.2	899	334	2173	570	12012
HM 116RR	5476	229	86.2	871	409	2303	533	12255
Liberty-link								
8CG9372LL	6713	283	88.2	896	333	2272	606	12604
Mean	6587.3	257.9	87.3	952.1	324.8	2349.3	577.6	12496.9
LSD (.05)	528.0	12.2	1.5	74.9	87.2	234.4	97.8	1316.6
C.V. (%)	7.9	4.7	1.7	7.8	26.5	9.8	16.7	10.4
F value	15.8**	19.6**	1.5NS	12.2**	2.9*	3.3*	1.1NS	0.5NS

NOTES: Round-up ready entries sprayed 1-14-99 with 1 qt/a Round-up Ultra. Liberty-link entry sprayed 1-4-99 with 28 ou/a Liberty. Otherwise plot was hand weeded and no conventional herbicides were used. Little weeding was required in Round-up and Liberty treated plots. Original planting in September had poor stand establishment due to flee beetles and strong winds. This trial was replanted in October, resulting in lower yields than the Area 5 Coded Mid-harvest trial.

CURLY TOP EVALUATION, SALINAS ENTRIES, 1999

180 entries x 3 replications, sequential
2-row plots, 12 ft. long

Not harvested for yield

Variety	Description	Stand Count[1] No.	BSDF 2nd[1] Score	LP 9/22/99[2] Score	CRT 9/14/99[3] Score
HYBRIDS					
US H11	Resistant check	20	4.0	4.3	4.3
WS-PM9	HM-WS-PM9, 4-18-95	23	4.0	4.0	2.0
B4776R	1-19-99	23	5.0	5.7	7.0
B4035R	Betaseed,	22	5.0	5.7	6.7
B4419R	1-19-99	22	4.0	4.3	5.0
B4430R	L4430.8052, 3-10-99	25	4.3	5.0	6.7
SS-432R	Spreckels, 2-8-99	23	4.0	4.3	5.7
Rizor	Spreckels, 2-8-99	23	5.7	6.3	7.3
Rifle	Spreckels, 2-8-99	25	5.7	6.0	7.7
SS-NB7R	Spreckels, 3-3-98	24	4.7	5.3	6.3
SS-778R	X782402, 3-3-98	26	4.0	3.3	4.3
Monohikari	Seedex, 2-18-97	24	5.0	5.7	7.3
CR812H50	C790-15CMS x RZM CR712	22	4.7	4.7	5.7
CR813H50	C790-15CMS x RZM CR713	24	4.0	4.7	5.0
R876-89-5NBH50	C790-15CMS x RZM-% C76-89-5	24	4.3	4.7	5.7
R876-89-5H50	C790-15CMS x RZM-% C76-89-5	22	5.0	4.7	6.0
R576-89-18H50	C790-15CMS x C76-89-18	24	4.7	5.3	6.0
R776-89-5H8	F82-546H3 x C76-89-5	24	4.3	5.0	6.0
R778H8	F82-546H3 x C78	21	4.3	4.3	4.7
R878%H50	C790-15CMS x RZM C78	23	4.3	4.0	4.7
R878H50	C790-15CMS x C78	22	4.7	4.7	4.7
R882H50	C790-15CMS x C82	17	4.7	5.0	6.7
R882H27	C831-4HO x C82	20	5.0	5.3	7.3
R882H37	C306/2CMS x C82	20	4.3	4.7	6.3
US H11	Resistant check	20	4.0	5.0	6.0
Y769H8	F82-546H3 x C69	20	4.3	4.7	6.0
Y769H39	C762-17CMS x C69	23	4.0	4.0	4.3
Y869H50	C790-15CMS x C69	24	4.0	4.3	5.0
Y869H15-1B	6818-1Baa x C69	22	4.3	4.3	6.0
Y869H5	C833-5aa x C69	23	4.3	5.0	6.0
Y869H15-2B	6818-2Baa x C69	25	4.3	5.0	5.7
Y869H27	C831-4CMS x C69	23	4.3	4.0	5.0
Y869H45	C867-1CMS x C69	24	4.0	4.3	4.7
Y869H46	7869-6HO x C69	26	4.3	4.7	5.3
Y869H18	7818HO x C69	26	4.3	4.7	6.0
Y869H29	C829-3aa x C69	22	4.3	5.0	6.0

CURLY TOP EVALUATION, SALINAS ENTRIES, 1999

(cont.)

Variety	Description	Stand Count[1] No.	BSDF 2nd[1] Score	LP 9/22/99[2] Score	CRT 9/14/99[3] Score
HYBRIDS (cont.)					
Y869H35	7835aa x C69	23	4.3	5.0	5.7
Y869H38	7838aa x C69	23	4.0	4.3	5.3
Y869H69	7869aa x C69	25	4.3	4.3	5.0
Y869H37	C306/2CMS x C69	25	4.3	4.3	5.3
Monohikari	Susceptible check	24	5.3	5.7	7.0
US H11	Resistant check	23	4.0	3.7	4.3
R879H50	C790-15CMS x C79-1Rz	23	4.0	4.7	5.3
R836H50	C790-15CMS x C79-8R22	24	3.7	4.3	5.0
R854H50	C790-15CMS x RZM R754	25	4.0	5.0	6.0
Y867H50	C790-15CMS x RZM C67	25	4.7	4.3	6.3
Y872H50	C790-15CMS x RZM-% C72	27	4.3	4.3	5.3
Y873BH50	C790-15CMS x RZM Y773	25	3.7	4.0	5.0
Y875H50 Sp	C790-15CMS x Y775	23	4.0	4.7	5.3
Y875H50 Iso	C790-15CMS x RZM Y775	28	4.3	5.3	4.7
Z831H50	C790-15CMS x RZM Z25/Z30	23	4.0	4.7	5.3
8924H50	C790-15CMS x 7924	25	4.0	4.7	5.7
8931H50	C790-15CMS x RZM 7931	26	4.7	5.0	5.3
8931H38	7838mmaa x RZM 7931	23	4.3	4.7	5.7
8932H50	C790-15CMS x 7932CT,…	23	4.0	4.3	4.3
8932H38	7838mmaa x 7932CT,…	23	4.0	4.3	5.7
8932H69	6869mmaa x 7932CT,…	23	4.0	4.0	4.7
HM-WS-PM9	HM-WS-PM9, 4-18-95	25	4.0	4.3	3.7
8935H50 Iso	C790-15CMS x R776-89-5H13	26	4.0	4.7	5.7
8935H38	7838mmaa x R776-89-5H13	21	4.3	5.3	6.0
8936H50	C790-15CMS x R776-89-5H31	26	4.3	5.0	5.3
8937H50	C790-15CMS x R776-89-5H11	25	4.3	4.7	5.0
8938H50	C790-15CMS x Z731H11	24	4.0	4.7	5.7
8939H50	C790-15CMS x Y769H31	24	4.0	4.3	5.0
8926H50 Iso	C790-15CMS x RZM 7926	25	4.0	4.7	5.0
8926H50 Sp	C790-15CMS x RZM 7926	24	4.0	4.0	4.0
R709-1H50	C790-15CMS x CR R509A-1	23	4.0	4.3	5.0
R710H50	C790-15CMS x CR R509/10-#	21	4.3	4.7	6.0
MULTIGERM, O.P. LINES					
US H11	Resistant check	26	4.0	4.3	4.7
97-US75	Inc. 268 (US75)	24	4.0	5.3	4.0
97-US22/3	Inc. Y009 (US22/3)	23	4.0	4.7	4.0
WS-PM9	HM-WS-PM9, 4-18-95	25	4.0	3.7	2.0

CURLY TOP EVALUATION, SALINAS ENTRIES, 1999

(cont.)

Variety	Description	Stand Count[1] No.	BSDF 2nd[1] Score	LP 9/22/99[2] Score	CRT 9/14/99[3] Score
MULTIGERM, O.P. LINES (cont.)					
97-SP22-0	Inc. SP7622-0	27	4.7	5.7	7.3
98-EL-02	RZM 94-RM-#s	24	4.7	5.3	6.7
98-EL-04	RZM 94-RM-#s	23	4.7	5.3	6.3
R576-89-18(Sp)	Inc. C76-89-18	22	4.3	5.0	6.0
R876-89-5NB	RZM-% C76-89-5NB	23	4.7	5.3	6.3
R878%	RZM C78	24	4.0	4.3	4.7
R878(Sp)	Inc. C78	22	4.0	4.0	3.0
R880	RZM C80	22	4.7	5.3	6.0
R881	RZM R776,R781,…	22	5.0	5.3	6.3
R882	Inc. C82	20	4.3	5.3	6.3
Y868	RZM Y768	23	4.7	5.0	5.7
Y869(Iso)	RZM C69	21	4.7	5.0	6.7
Y869(Sp)	Inc. C69	24	4.7	5.0	5.7
P601	PMR P401	23	4.0	4.3	4.3
P811	RZM-PMR 6203-6208	24	4.0	4.7	5.7
P813	Inc. CP01	25	3.7	4.3	5.0
P814	Inc. CP02	25	4.0	4.3	5.3
R824	RZM C79-2/3, WB41/42	22	3.7	4.3	4.3
R835	RZM C79-7, SES	22	4.0	4.3	5.0
R836	RZM C79-8, R22	25	3.7	4.3	5.0
R879	RZM C79-1,*Rz*	22	3.7	4.3	3.7
US H11	Resistant check	20	3.7	4.7	4.0
R840	RZM R740 (C79#s)	24	4.3	5.0	5.0
R853	RZM-ER-% R653	25	4.3	4.7	5.3
R854	RZM R754	24	4.0	4.7	4.7
R726	RZM-ER R526, (C26)	26	4.0	5.0	5.3
R827	RZM R727A,B	21	4.7	5.0	6.7
Y866	RZM Y766	22	4.7	5.0	6.0
Y867	RZM C67	24	4.7	5.0	6.3
Y871	RZM Y771	23	4.3	5.3	6.0
Y872	RZM-% C72	22	4.0	5.0	6.3
Y872B	RZM C72	22	4.3	5.3	6.0
Y873	RZM-ER-% Y673	23	4.0	4.7	5.7
Y873B	RZM Y773	22	4.3	5.0	6.0
Y875(Iso)	RZM Y775	23	4.7	5.7	6.3
Y875(Sp)	RZM Y775,…,Y767	20	4.3	5.0	6.0

CURLY TOP EVALUATION, SALINAS ENTRIES, 1999

(cont.)

Variety	Description	Stand Count[1] No.	BSDF 2nd[1] Score	LP 9/22/99[2] Score	CRT 9/14/99[3] Score
MULTIGERM, S^f,Aa POPULATIONS & LINES					
CR811	RZM CR09/CR10	19	5.0	5.7	6.7
CR812	RZM CR712	23	4.7	5.3	6.3
CR813	RZM CR713	23	5.0	5.3	6.0
WS-PM9	HM-WS-PM9, 4-18-95	22	4.0	4.3	3.0
8932M	7932CTaa x A	24	4.0	4.3	4.3
Y869H30M	7932CTaa x C69	21	4.3	5.0	5.7
P812	RZM-PMR 6211-6217	23	4.0	4.3	4.0
Z831	RZM Z731-Z725aa x A	21	4.0	5.0	6.0
8924	RZM 7924aa x A	22	4.7	4.7	6.7
8931	RZM 7931aa x A	21	4.3	5.0	5.7
Y869H31	7931aa x C69	20	4.0	5.0	5.3
8935(Iso)	RZM R776-89-5H13	23	4.7	5.7	6.7
8936	RZM R776-89-5H31	21	4.7	5.3	6.0
8937	RZM R776-89-5H11	22	4.3	5.3	6.3
8938	RZM Z731H11	22	5.0	5.7	7.0
8939	RZM Y769H31	22	4.3	5.0	5.7
8926(Iso)	RZM 7926	23	4.3	5.0	5.7
8926(Sp)	7931aa x RZM 7926	25	3.7	4.7	4.3
N724	Inc. N623,N624	19	4.0	4.7	5.3
7747	Inc. 5747(A,aa)	20	4.0	4.7	4.7
Z825-6	Inc. Z625-6	20	4.0	5.0	5.7
Z825-9	Inc. Z625-9	22	4.3	5.3	7.0
Z830-11	Inc. Z630-11	22	4.0	5.0	6.7
8911-4-10M	RZM-ER-% 6911-4-10	22	4.0	4.3	3.3
8913-70	RZM-ER-% C913-70	22	4.3	5.0	6.7
8918-12	RZM-ER-% 6918-12	17	4.7	5.3	6.3
8925-19	Inc. 6925-19	20	4.3	5.3	6.7
8927-29	Inc. 6927-29	20	5.3	6.3	7.7
8927-30	Inc. 6927-30	20	4.7	4.7	6.0
8927-33	Inc. 6927-33	18	4.0	4.7	4.7
8927-37	Inc. 6927-37	17	4.3	6.0	6.3
8929-41	Inc. 6929-41	18	5.3	6.3	7.3
8929-72	Inc. 6929-72	17	5.0	5.7	6.7
8929-102	Inc. 6929-102	23	5.0	5.0	6.7
8929-112	Inc. 6929-112	22	4.3	4.7	5.7
8929-114	Inc. 6929-114	20	4.7	4.7	6.3
8929-115	Inc. 6929-115	18	4.3	5.0	6.3
8929-133	Inc. 6929-133	18	4.3	5.0	5.3

CURLY TOP EVALUATION, SALINAS ENTRIES, 1999

(cont.)

Variety	Description	Stand Count[1] No.	BSDF 2nd[1] Score	LP 9/22/99[2] Score	CRT 9/14/99[3] Score
MULTIGERM, S^f,Aa POPULATIONS & LINES (cont.)					
8929-153	Inc. 6929-153	18	4.7	5.7	6.7
8929-154	Inc. 6929-154	21	4.7	4.7	6.7
8930-19	Inc. 6930-19	23	4.7	5.3	5.3
8930-39	Inc. 6930-39	20	4.3	4.7	5.0
8930-102	Inc. 6930-102	16	4.0	5.0	6.0
US H11	Resistant check	24	4.0	4.3	5.3
MONOGERM, S^f,Aa POPULATIONS & LINES					
7818%M	RZM-ER 5818 (C890-8,R22)	21	4.3	5.3	6.3
8818-1B	Inc. 6818-1B	21	4.0	5.0	6.3
8818-2B	Inc. 6818-2B	25	4.7	5.3	6.3
6546	Inc. F82-546 (C546)	18	4.0	5.0	5.7
6718	Inc. U83-718 (C718)	13	4.0	4.3	3.3
7864-14M	Inc. C864-14	20	4.0	5.0	5.7
8833-5H50	C790-15CMS x 5833-5	26	4.0	4.7	5.7
8833H50	C790-15CMS x RZM,T-O 7833	28	4.0	4.3	5.0
6869(Sp)	5869mmaa x A	25	4.0	4.3	5.3
8869	RZM 7869-#s	29	4.3	4.7	6.0
8890m	RZM 7890	23	4.3	4.7	5.7
8833	RZM,T-O 7833-#s	24	4.7	5.3	6.7
8836	T-O 7836-#s	24	4.7	5.3	7.0
8835	7835mmaa x A	24	4.0	5.0	6.0
8835H50	C790-15CMS x 7835	22	4.0	4.3	5.3
8838	7838mmaa x A	22	4.0	4.7	5.7
8838H50	C790-15CMS x 7838	24	4.0	4.7	5.7
8848M	RZM 7848	24	4.0	5.0	5.7
8810M	RZM 7810NB	24	4.0	4.7	4.7
8829-3	Inc. C829-3	24	4.7	5.3	5.7
8831-3	Inc. C831-3	24	4.7	5.3	6.3
8831-4	T-O C831-4-#s	22	5.0	5.0	6.3
8833-5	Inc. C833-5	24	4.7	5.0	6.0
8833-12	Inc. C833-12	23	4.7	5.0	6.7
7867-1M	Inc. T-O C867-1 (CTR)	21	5.3	5.7	6.7
7869-6	T-O 6869-6 (barbed)	24	4.3	5.0	6.0
6762-17	Inc. 0762-17 (C762-17)	24	4.0	3.7	2.7
6562	Inc. F82-562 (C562)	18	4.0	4.0	5.0

[1] By Beet Sugar Development Foundation
[2] By Dr. Lee Panella, USDA-ARS, Fort Collins
[3] By Dr. Clyde Trupp

TEST 3199-2. EVALUATION OF PROGENY LINES FOR POWDERY MILDEW RESISTANCE, SALINAS, CA., 1999 (USDA entries)

21 entries x 4 reps, sequential
1-row plots, 11 ft. long

Planted: April 13, 1999
Not harvested for yield

Variety	Description	Stand Count Mean	Powdery Mildew Score 08/12	08/20	08/26	09/02	Mean
USDA entries							
US H11	Susc. check	18	4.8	7.0	7.5	7.3	6.6
Rizor	Spreckels,2-8-99	17	4.0	6.3	7.0	7.5	6.2
Rival	HH103, L1032406	16	4.5	6.8	7.3	8.0	6.6
B4430R	Betaseed 4430.8052, 3-10-99	18	3.0	4.8	5.3	6.3	4.8
P811	RZM-PMR 6203-6208(C)	18	3.8	4.8	5.8	6.3	5.1
P812	RZM-PMR 6211-6217(C)	18	3.5	5.0	6.0	6.8	5.3
P813	Inc. 6201-6202(C)	17	3.8	5.0	5.8	5.8	5.1
P814	Inc. 6205-6206(C)	15	2.8	4.0	5.0	5.3	4.3
P601	PMR P401	17	3.0	4.5	5.0	4.8	4.3
P603	PMR P403	18	3.0	3.5	4.8	4.3	3.9
P604	PMR P404	17	3.0	3.8	4.8	4.8	4.1
8918-12	RZM-ER-% 6918-12	17	1.8	3.0	3.5	3.8	3.0
Y039	Inc. Y939 (C39)	15	2.8	4.0	4.8	4.3	3.9
Y869(Iso)	RZM Y769 (C69)	14	3.3	4.5	5.3	5.0	4.5
8939	RZM Y769H31	15	2.5	4.3	5.0	5.0	4.2
R878%	RZM R778%	17	3.0	5.0	6.3	6.3	5.1
B4776R	Betaseed, 1-19-99	18	3.8	5.8	7.0	6.8	5.8
Rifle	Spreckels, 2-8-99	16	4.3	6.5	7.8	7.3	6.4
SS-432R	Spreckels, 2-8-99	15	3.5	5.3	6.5	6.0	5.3
SS-778R	Spreckels, X782402, 9-16-98	17	3.5	4.8	6.0	6.5	5.2
B4419R	Betaseed, 1-19-99	16	4.5	7.0	8.3	7.5	6.8
Mean		16.6	3.4	5.0	5.9	6.0	5.1
LSD (.05)		1.9	1.1	1.1	1.1	1.0	0.8
C.V. (%)		8.0	21.9	14.8	13.0	12.3	11.6
F value		3.3**	3.9**	9.6**	9.9**	11.3**	12.7**

Notes: P811, P812, P813, P814, P601, P603, P604 segregate for resistance to powdery mildew. Resistance was transferred to C37 from *Beta maritima* lines WB97 and WB242. On a plot basis, the PM ratings largely reflect the C37-type susceptible segregates.

TEST 3499. ERWINIA/POWDERY MILDEW EVALUATION OF LINES AND POPULATIONS, SALINAS, CA., 1999

80 entries x 3 reps., sequential
1-row plots, 17 1/2 ft. long

Planted: April 13, 1999
Inoc. Ecb: July 14, 1999
Scored Ecb: Nov. 12, 1999

Variety	Description	Powdery Mildew Score					Stand Count	Harvest Count	Erwinia Rating	
		08/23	08/31	09/08	10/04	Mean	No.	No.	DI	%H
Multigerm, open-pollinated										
US H11	113102 (resistant check)	7.0	7.0	7.7	8.0	7.4	28.3	28.7	7.9	81.5
E740	Inc. E840 (C40 susc. ck.)	8.3	8.7	9.0	8.7	8.7	31.0	30.3	79.3	14.3
97-US22/3	Inc. Y009 (US22/3)	6.3	6.7	7.3	8.0	7.1	31.3	31.7	19.7	68.7
97-US75	Inc. 268 (US75)	6.7	7.0	7.3	8.0	7.3	31.0	33.0	14.6	74.7
97-C37	Inc. U86-37 (C37)	7.0	7.3	7.3	8.0	7.4	25.3	29.0	4.8	90.6
R878% (Iso)	RZM R778%, (C78)	5.0	5.7	6.0	6.7	5.8	24.0	24.7	2.0	91.2
R878 (Sp)	Inc. R778, R778%	5.3	5.7	6.3	6.7	6.0	23.3	23.3	3.5	87.0
P601	PMR P401	4.0	4.7	5.3	5.7	4.9	24.7	26.3	5.7	93.5
R880	RZM R780, (C80)	4.7	5.3	6.0	7.3	5.8	22.7	24.3	1.7	94.3
R882 (Sp)	Inc. R781, R776, R781-43,…	4.7	5.0	6.3	6.7	5.7	25.0	27.3	3.8	90.9
R881 (Iso)	RZM R776, R781, R681,…	4.7	6.0	6.3	7.0	6.0	22.0	22.7	4.8	89.8
R776	RZM-ER R576	5.3	7.0	7.3	7.3	6.8	24.0	23.7	8.9	84.9
R781	RZM-ER R581	3.7	4.3	5.7	6.0	4.9	30.3	33.0	8.6	82.1
R770	RZM-ER R570	5.0	5.7	6.7	7.0	6.1	28.3	28.3	8.7	84.1
98-EL02	F_2 (C80 x smooth root)	5.3	6.7	7.0	7.7	6.7	32.7	33.7	6.2	90.1
98-EL04	F_2 (C80 x smooth root)	5.7	6.7	7.0	7.0	6.6	30.7	33.0	7.2	87.2
R879	RZM R779, (C79-1,*Rz*)	5.3	6.7	7.7	7.7	6.8	27.0	30.7	1.5	92.4
R836	RZM R736, R743 (C79-8,R22)	7.7	8.0	8.0	8.7	8.1	29.7	31.0	18.2	75.3
R853	RZM-ER-%S R653	5.7	7.0	7.0	8.0	6.9	29.0	29.0	2.0	94.2
R854	RZM R754	6.3	8.0	8.0	9.0	7.8	32.7	35.7	1.6	95.3

TEST 3499. ERWINIA/POWDERY MILDEW EVALUATION OF LINES AND POPULATIONS, SALINAS, CA., 1999

(cont.)

Variety	Description	Powdery Mildew Score					Stand Count	Harvest Count	Erwinia Rating	
		08/23	08/31	09/08	10/04	Mean	No.	No.	DI	%H
Multigerm, open-pollinated (cont.)										
Y873	RZM-ER-%S Y673	5.7	6.3	6.3	7.3	6.4	28.0	28.7	7.6	83.8
Y873B	RZM Y773	6.3	7.0	7.7	7.0	7.0	31.7	28.3	3.1	93.7
US H11	113102	6.3	7.7	8.7	8.7	7.8	31.0	32.3	0.5	97.9
E740	Inc. E840	7.0	9.0	9.0	9.0	8.5	28.7	34.0	54.1	40.6
R576-89-18 (Sp)	Inc. R476-89-18	4.0	4.0	5.0	6.7	4.9	28.7	32.3	7.5	87.6
R876-89-5NB	RZM-%S R576-89-5NB	4.3	5.0	5.0	5.7	5.0	31.7	31.3	7.9	89.2
Y866	RZM Y766	4.3	5.0	5.7	7.0	5.5	34.0	33.7	7.1	85.2
Y868	RZM Y768	3.7	4.0	4.7	6.0	4.6	31.0	32.3	2.0	97.9
Y769 (Iso)	RZM-ER Y569	4.0	5.0	5.7	6.7	5.3	21.0	33.0	3.6	94.0
Y869 (Iso)	RZM Y769 (C69)	5.0	5.0	5.7	6.7	5.6	25.3	29.7	3.4	96.6
Y869 (Sp)	Inc. Y769(C69)	5.0	5.7	6.0	7.0	5.9	29.0	31.3	1.7	97.8
Y871		5.7	6.3	7.7	8.0	6.9	30.7	31.0	9.9	87.5
Y867	RZM Y767 (C67)	4.0	4.0	5.7	6.0	4.9	28.0	34.0	11.2	75.0
Y872	RZM-%S Y672	4.7	5.7	6.7	7.0	6.0	31.0	33.0	22.9	62.6
E740	Inc. E840	7.0	8.0	8.7	8.0	7.9	30.7	31.0	92.4	6.4
US H11	113102	6.0	7.0	7.7	9.0	7.4	32.7	32.3	1.7	84.5
Y872B	RZM Y772 (C72)	5.0	6.0	6.7	7.0	6.2	28.7	31.3	14.8	62.9
Y875 (Iso)	RZM Y775	4.3	5.3	6.0	6.3	5.5	30.7	32.7	10.8	74.9
Y875 (Sp)	RZM Y775,Y773,Y772,Y767	5.3	5.7	6.0	6.7	5.9	31.0	32.7	8.0	80.2
R840	RZM R740 (C79-#s)	6.3	7.0	8.7	8.3	7.6	29.7	31.7	7.7	81.1
R726 (C26)	RZM-ER R526	6.0	6.3	7.7	8.0	7.0	29.0	33.0	12.4	77.6
R827 (C27)	RZM R727A,B	4.7	5.0	6.0	7.0	5.7	30.7	33.0	5.1	80.6

TEST 3499. ERWINIA/POWDERY MILDEW EVALUATION OF LINES AND POPULATIONS, SALINAS, CA., 1999

(cont.)

Variety	Description	Powdery Mildew Score					Stand Count	Harvest Count	Erwinia Rating	
		08/23	08/31	09/08	10/04	Mean	No.	No.	DI	%H
Multigerm, S^f, Aa populations										
8926 (Iso)	RZM 7926 (A,aa)	4.7	5.7	6.7	7.7	6.2	30.7	31.3	4.7	86.4
8926 (Sp)	7931aa x RZM 7926	4.7	6.0	6.7	6.7	6.0	30.7	31.7	4.7	87.3
8927	RZM 7926aa x A	5.0	5.7	6.0	6.7	5.8	29.7	32.7	5.5	88.0
7931	6931aa x 931(C)	4.3	5.7	6.0	6.7	5.7	31.0	31.7	2.0	90.5
8931	RZM 7931aa x A	5.3	6.0	6.7	7.0	6.3	31.0	30.3	4.3	90.1
8924	RZM 7924,…aa x 924(C)	5.7	7.0	6.7	7.7	6.8	29.7	30.3	6.3	85.7
Z831	RZM Z731,Z730aa x A	5.0	6.0	7.0	8.0	6.5	29.0	32.0	13.8	70.5
CR811	RZM CR711 (CR09/10)	5.0	5.7	6.7	7.7	6.3	32.0	33.7	6.7	85.5
CR812	RZM CR712	5.0	6.0	7.0	8.0	6.5	31.0	32.3	4.4	81.8
CR813	RZM CR713	5.3	6.0	7.3	8.0	6.7	27.7	28.7	9.5	79.1
US H11	113102	6.7	7.0	7.7	8.7	7.5	28.0	31.7	3.9	82.2
E740	Inc. E840	8.0	8.7	9.0	8.7	8.6	30.0	30.0	82.9	12.2
P811	RZM-PMR 6203-#,6208-#(C)	4.0	4.7	5.3	5.7	4.9	25.0	26.3	2.8	85.9
P812	RZM-PMR 6211-#,6217-#(C)	5.3	5.3	6.7	7.0	6.1	25.7	29.0	3.6	87.5
P813 (CP01)	Inc. 6201-#,6202-#(C)	5.0	5.3	5.7	7.0	5.8	25.7	25.7	11.0	68.5
P814 (CP02)	Inc. 6205-#,6206-#(C)	5.0	5.3	6.0	6.3	5.7	26.0	26.7	1.6	94.0
N724	Inc. N623,N624 (galls)	6.3	6.7	7.0	8.3	7.1	28.0	27.3	11.6	74.8
N730	Inc. N629,N630 (galls)	5.7	6.0	6.7	6.3	6.2	27.0	26.3	15.3	73.5
8932	7932CT,7201,…aa x A	7.0	7.3	7.3	8.3	7.5	29.7	31.7	31.1	57.7
8932Am	Inc. 7932CT,7201…A	7.0	7.0	7.0	7.7	7.2	29.0	29.0	21.8	66.6
8932HO(M)	7204-7216CMS x A	7.3	7.0	8.0	7.7	7.5	31.0	30.3	16.0	67.5
8932H69	6869mmaa x A	6.3	7.0	7.3	8.0	7.2	30.7	31.3	24.1	59.5

TEST 3499. ERWINIA/POWDERY MILDEW EVALUATION OF LINES AND POPULATIONS, SALINAS, CA., 1999

(cont.)

Variety	Description	Powdery Mildew Score					Stand Count	Harvest Count	Erwinia Rating	
		08/23	08/31	09/08	10/04	Mean	No.	No.	DI	%H
Multigerm, S^f, Aa populations (cont.)										
8935 (Sp)	Inc. R776-89-5H13Aa	5.3	6.0	7.0	7.0	6.3	33.0	34.0	5.2	89.3
8935 (Iso)	RZM R776-89-5H13	6.0	6.7	6.7	7.0	6.6	32.3	32.0	4.2	87.6
US H11	113102	7.3	7.7	8.0	8.7	7.9	33.7	32.7	2.8	85.5
E740	Inc. E840	8.7	9.0	9.0	8.0	8.7	29.7	29.7	85.4	7.8
8936	RZM R776-89-5H31	4.7	5.0	6.0	6.0	5.4	29.3	31.7	5.8	89.5
8937	RZM R776-89-5H11	3.7	5.0	5.7	6.3	5.2	31.3	31.0	1.4	97.7
8938	RZM Z731H11	5.3	5.3	6.0	6.3	5.8	31.3	30.0	2.8	93.0
8939	RZM Y769H31	5.3	5.7	6.7	7.0	6.2	29.0	29.0	10.2	80.3
Y869H31	7931aa x Y769	4.3	5.0	5.7	6.7	5.4	25.3	32.0	2.5	97.0
7933	Inc. 6264-#(C)	5.3	5.7	6.3	7.3	6.2	31.7	31.3	5.3	91.5
R710	CR-RZM R509-#,R510-#(C)	6.3	7.0	7.3	7.7	7.1	30.0	30.3	4.0	95.5
R709-1	CR-RZM R509A-1	6.0	6.0	7.3	8.0	6.8	28.3	31.3	4.2	91.4
R709-9	CR-RZM R509A-9	3.7	4.3	5.7	6.7	5.1	26.7	29.0	7.4	75.6
Z725	Z625-#(C)aa x Z31(C)	5.0	6.0	7.0	6.7	6.2	29.3	29.7	10.8	77.9
Z730	Z630-#(C)aa x Z31(C)	6.0	7.0	7.7	7.7	7.1	30.7	31.0	15.3	77.0
7747	Inc. 5747 (A,aa)	7.0	7.3	8.0	8.3	7.7	30.7	30.7	3.4	95.8
Mean		5.5	6.2	6.8	7.3	6.5	29.1	30.5	12.1	80.1
LSD (.05)		1.5	1.1	1.0	1.0	0.9	6.7	6.4	5.6	10.8
C.V. (%)		16.5	11.1	9.1	8.1	8.1	14.3	13.1	28.7	8.3
F value		4.6**	8.4**	8.1**	6.2**	10.6**	1.3NS	1.4NS	86.9**	25.2**

TEST 3599. ERWINIA/POWDERY MILDEW EVALUATION OF MULTIGERM, S^f,Aa PROGENY LINES, SALINAS, CA., 1999

40 entries x 3 reps., sequential
1-row plots, 17 1/2 ft. long

Planted: April 13, 1999
Inoculated Ecb: July 14, 1999
Scored Ecb: Nov. 12, 1999

Variety	Description	Powdery Mildew Score					Stand Count	Harvest Count	ERR-DI	ERR-%H
		08/23	08/31	09/08	10/04	Mean	No.	No.	Score	%
Commercial Hybrids										
Rifle	Spreckels, 2-8-99	7.0	7.0	8.3	8.0	7.6	29.0	30.0	17.8	76.4
B4776R	Betaseed, 1-19-99	6.7	7.0	7.3	7.3	7.1	29.7	30.0	18.6	73.5
US H11	*Ecb*. Resist. ck.	8.0	8.0	8.3	8.7	8.3	25.0	31.7	1.0	96.8
E740	Inc. E840, *Ecb* susc. ck.	9.0	9.0	9.0	8.3	8.8	28.7	31.0	72.4	20.7
Rizor	Spreckels, 2-8-99	6.7	7.0	7.7	7.0	7.1	29.3	31.0	10.5	71.3
B4419R	Betaseed, 1-19-99	7.3	7.3	7.7	8.0	7.6	31.7	32.0	24.2	58.7
SS-432R	Spreckels, 2-8-99	6.3	6.3	6.7	7.0	6.6	32.0	28.3	2.9	91.9
SS-778R	Spreckels, X782402, 9-16-98	6.0	6.3	6.7	7.0	6.5	30.0	31.7	22.2	60.0
B4430R	Betaseed 4430.8052, 3-10-99	5.7	5.7	6.7	6.7	6.2	34.0	34.0	12.3	79.3
SS-NB7R	Spreckels, 3-3-98	6.7	7.0	7.3	7.3	7.1	29.3	30.0	14.5	74.1
B4035R	Betaseed, 7-10-97	6.3	7.0	7.7	7.0	7.0	29.7	31.7	18.6	72.7
Rival	HH103, L1032406, 3-18-97	7.3	7.7	8.7	8.3	8.0	30.7	34.0	14.1	74.5
Increases of S_1, MM, S^f, Aa progeny lines										
8913-70	RZM-ER-%S 6913-70	6.0	6.0	7.3	7.0	6.6	30.7	31.7	0.1	99.0
8918-12	RZM-ER-%S 6918-12	4.0	4.7	5.0	5.0	4.7	31.0	31.3	1.3	94.8
8918-21	RZM 7918-21	5.0	5.7	6.3	6.3	5.8	22.3	24.7	2.9	89.5
8911-4-10M	RZM-ER-%S 6911-4-10	4.3	4.7	6.0	6.7	5.4	28.0	27.7	7.3	79.9
8925-19	Inc. 6915-19	5.0	5.7	6.3	7.3	6.1	29.0	28.3	5.6	85.9
Z825-6	Inc. Z625-6 (A,aa)	6.3	7.3	7.7	7.7	7.3	33.0	33.7	3.6	91.1
Z825-9	Inc. Z625-9 (A,aa)	4.7	5.0	5.7	6.0	5.3	28.3	30.3	23.8	65.8
Z830-11	Inc. Z630-11 (A,aa)	3.7	4.0	5.3	5.3	4.6	29.7	28.7	7.9	84.9
E740	Inc. E840	8.7	8.7	8.7	8.3	8.6	28.0	27.7	88.7	8.9
US H11	*Ecb* resist. ck.	7.3	7.3	7.3	8.0	7.5	33.0	32.3	4.2	85.8
8929-41	Inc. 6929-41 (A,aa)	4.3	5.0	5.7	5.3	5.1	25.0	28.7	3.7	88.8
8929-72	Inc. 6929-72 (A,aa)	4.3	4.7	5.3	5.7	5.0	29.7	31.7	14.9	82.5

TEST 3599. ERWINIA/POWDERY MILDEW EVALUATION OF MULTIGERM, S^f,Aa PROGENY LINES, SALINAS, CA., 1999

(cont.)

Variety	Description	Powdery Mildew Score 08/23	08/31	09/08	10/04	Mean	Stand Count No.	Harvest Count No.	ERR-DI Score	ERR-%H %
Increases of S_1, MM, S^f, Aa progeny lines (cont.)										
8929-102	Inc. 6929-102 (A,aa)	5.0	5.7	6.0	5.7	5.6	30.7	32.7	0.3	99.0
8929-112	Inc. 6929-112 (A,aa)	5.7	5.7	7.0	6.7	6.3	29.3	31.0	0.7	96.9
8929-114	Inc. 6929-114 (A,aa)	4.7	5.3	6.3	5.7	5.5	28.3	31.3	20.8	69.6
8929-115	Inc. 6929-115 (A,aa)	4.0	5.0	6.0	6.0	5.3	25.7	26.3	8.4	82.2
8929-133	Inc. 6929-133 (A,aa)	5.7	6.0	7.0	6.0	6.2	25.0	27.0	9.2	79.2
8929-153	Inc. 6929-153 (A,aa)	5.3	6.0	6.7	6.3	6.1	29.3	30.7	0.6	95.6
8929-154	Inc. 6929-154 (A,aa)	4.0	4.7	5.7	5.3	4.9	24.7	26.0	1.0	98.8
8930-19	Inc. 6930-19 (A,aa)	4.3	5.3	6.3	6.7	5.7	29.7	30.0	6.3	87.8
8930-39	Inc. 6930-39 (A,aa)	4.7	5.0	6.0	6.3	5.5	28.7	29.0	7.6	85.3
8930-102	Inc. 6930-102 (A,aa)	6.3	6.7	7.7	7.7	7.1	27.3	27.3	1.5	94.1
8927-29	Inc. 6927-29 (A,aa)	4.7	5.3	6.0	5.3	5.3	26.7	28.0	1.3	97.7
8927-30	Inc. 6927-30 (A,aa)	4.0	5.3	6.7	7.0	5.8	28.0	28.0	5.7	82.2
8927-33	Inc. 6927-33 (A,aa)	6.3	6.3	7.0	6.0	6.4	29.7	31.7	0.6	94.9
8927-37	Inc. 6927-37 (A,aa)	6.7	7.0	6.7	6.7	6.8	26.7	29.0	5.8	86.6
E740	Inc. E840	9.0	9.0	9.0	8.0	8.8	30.0	31.7	73.3	21.1
US H11	*Ecb* resist. ck.	7.3	7.3	8.0	8.7	7.8	31.0	34.3	3.1	89.2
Mean		5.9	6.2	6.9	6.8	6.5	28.9	30.2	13.5	79.2
LSD (.05)		0.9	0.9	0.8	0.9	0.6	5.7	4.6	8.9	14.0
C.V. (%)		9.5	8.6	7.3	8.5	6.1	12.1	9.5	40.6	10.9
F value		20.4**	16.4**	12.8**	9.4**	25.5**	1.5NS	2.0**	40.3**	17.7**

TEST 3699. ERWINIA/POWDERY MILDEW EVALUATION OF MONOGERM POPULATIONS AND LINES, SALINAS, CA., 1999

40 entries x 3 reps., sequential
1-row plots, 17 1/2 ft. long

Planted: April 13, 1999
Inoc. Ecb: July 14, 1999
Scored Ecb: Nov. 12, 1999

Variety	Description	Powdery Mildew Score 08/23	08/31	09/08	10/04	Mean	Stand Count No.	Harvest Count No.	Erwinia Rating DI	%H
Monogerm populations										
7835	6833,%,6834%aa x A	7.0	7.0	7.7	7.7	7.3	30.3	33.3	16.8	74.0
8835m	7835,…mmaa x A	6.7	6.7	7.3	7.7	7.1	30.0	31.3	15.0	75.4
8835HO	7835H50 x 7835	6.3	6.7	7.3	7.3	6.9	30.7	32.0	21.6	65.9
8835H50	C790-15CMS x 7835	6.7	6.7	7.3	7.0	6.9	29.0	31.0	26.2	57.9
7838	6828,6836,…aa x A	6.3	6.3	7.3	6.7	6.7	26.7	31.7	11.9	75.0
8838m	7838mmaa x A	6.7	6.7	7.0	7.3	6.9	28.3	29.7	20.2	59.6
8838HO(B)	7838H50 x 7838	5.7	5.7	6.3	6.0	5.9	32.0	33.0	9.5	81.5
8838H50	C790-15CMS x 7838	6.3	6.7	7.3	7.0	6.8	32.7	33.0	14.5	71.4
US H11	*Ecb* resist. ck.	7.7	7.3	8.3	8.3	7.9	30.7	33.3	2.6	89.7
E740	Inc. E840, *Ecb* susc. ck.	9.0	9.0	9.0	8.0	8.8	30.3	31.0	77.2	18.8
6869m	5869mmaa x A	6.7	7.0	7.3	8.0	7.3	32.0	33.7	20.3	68.5
7869NB	NB-RZM 5869	6.7	6.7	7.3	7.7	7.1	32.0	33.7	16.1	67.3
8869m	RZM 7869-#(C)	6.0	6.3	7.3	7.7	6.8	28.0	28.7	28.9	63.9
8869HO	7869HO x RZM 7869-#(C)	7.0	7.0	8.0	8.3	7.6	30.7	31.7	29.2	50.6
8890m	RZM 7890,RZM-%S 6890,5890	6.7	6.7	7.0	7.7	7.0	28.0	28.7	4.9	85.1
8810M	RZM 7810NB	6.3	6.7	7.3	7.3	6.9	29.3	29.7	31.5	51.1
8848M	RZM 7848M	7.0	7.0	7.3	6.7	7.0	31.7	31.3	17.6	65.2
8833	RZM,T-O 7833-#(C),7834-#(C)	7.7	8.0	8.7	8.3	8.2	30.3	30.0	19.8	70.3
8836	T-O 7836-#, 7837-#	7.0	7.0	8.0	7.0	7.3	30.7	31.7	7.6	85.4
97-546	Inc. F82-546 (C546)	7.3	7.3	7.3	8.0	7.5	24.7	26.3	3.4	91.4

TEST 3699. ERWINIA/POWDERY MILDEW EVALUATION OF MONOGERM POPULATIONS AND LINES, SALINAS, CA., 1999

(cont.)

Variety	Description	Powdery Mildew Score					Stand Count	Harvest Count	Erwinia Rating	
		08/23	08/31	09/08	10/04	Mean	No.	No.	DI	%H
Monogerm lines										
8829-3	Inc. 5829-3 (A,aa), C829-3	7.0	7.3	8.3	8.0	7.7	28.3	31.3	23.6	66.7
8829-3H50	C790-15CMS x 5829-3, C829-3CMS	6.7	7.0	7.7	7.7	7.3	27.7	28.7	29.6	56.7
8831-3	Inc. 5831-3 (A,aa), C831-3	6.3	5.7	7.0	6.7	6.4	28.7	29.3	48.6	39.9
8831-3H50	C790-15CMS x 5831-3, C831-3CMS	6.7	6.3	7.3	7.0	6.8	28.7	30.7	45.3	37.8
8831-4	T-O 7831-4-#, C831-4	7.7	8.0	8.3	7.7	7.9	28.3	29.0	45.7	43.2
8831-4HOM	6831-4HOM x 7831-4-#, C831-4CMS	5.7	6.3	7.0	6.7	6.4	24.0	25.3	13.1	76.9
8833-5	Inc. 5833-5 (A,aa), C833-5	6.7	7.3	8.3	8.0	7.6	25.7	26.3	6.6	83.7
8833-5H50	C790-15CMS x 5833-5, C833-5CMS	6.3	7.0	7.7	7.3	7.1	26.7	27.3	18.7	66.4
8833-12	Inc. 5833-12 (A,aa), C833-12	7.3	7.3	8.7	8.3	7.9	24.3	26.0	39.0	42.0
8833-12H50	C790-15CMS x 5833-12, C833-12CMS	6.7	6.7	7.7	7.3	7.1	28.0	28.3	33.5	42.4
E740	Inc. E840	9.0	9.0	9.0	8.0	8.8	29.0	30.7	86.8	8.6
US H11	*Ecb* resist. ck.	7.0	6.7	7.3	8.0	7.3	28.0	30.0	5.0	83.1
Topcross hybrids with monogerm lines										
Y869H5	5833-5aa x Y769	4.3	5.7	6.3	6.7	5.8	27.0	26.3	8.8	75.1
Y869H27	6831-4HO x Y769	4.7	5.0	5.7	6.7	5.5	27.7	30.0	15.8	70.3
Y869H29	5829-3aa x Y769	7.0	7.7	8.0	8.0	7.7	27.7	29.7	4.7	90.2
Y869H46	7869-6HO x Y769	6.0	6.3	7.0	7.0	6.6	30.3	31.0	5.3	83.5
Y869H45	7867-1HO x Y769	5.3	5.7	6.0	7.0	6.0	29.3	32.3	11.0	82.4
Y869H35m	7835mmaa x Y769	6.3	6.3	7.0	7.0	6.7	30.0	32.7	13.0	71.0
Y869H38m	7838mmaa x Y769	6.0	5.7	6.3	6.7	6.2	32.0	34.3	11.6	75.8
Y869H69	7869aa x Y769	6.3	6.7	7.0	7.7	6.9	32.0	33.0	11.1	78.4
Mean		6.6	6.8	7.5	7.4	7.1	29.0	30.4	21.8	66.0
LSD (.05)		1.1	0.9	0.9	0.8	0.7	4.6	4.3	14.0	20.8
C.V. (%)		10.6	8.2	7.6	6.8	6.1	9.7	8.8	39.6	19.4
F value		4.8**	6.4**	5.4**	4.2**	8.2**	1.9*	2.3**	13.7**	6.6**

CERCOSPORA LEAF SPOT EVALUATION OF SALINAS ENTRIES, 1999

Variety	Description	Ft. Collins	Shakopee		Italy	
		Sep 22	RR	Mean	07/27	08/17
97-SP22-0	LSR-AR check	3.3	1.5	4.2	1	6
B4430R	L4330.8052, 3-10-97 (CS check)	7.3	2.3	5.7	6	8
Monodoro	Resist. check	4.3	2.8	3.6	1	5
Ippolita	Resist. check	4.7	3.1	3.5		
Rifle	Commercial check	6.5	3.1	4.9		
Y869	RZM Y769, C69	5.0	3.2	4.0		
Y875	RZM Y775	5.5	1.9	4.7		
CR811	RZM CR711, CR09/10	4.7	2.6	3.9	3	7
CR812	RZM CR712	5.3	2.9	4.1	4	7
CR813	RZM CR713	5.5	3.3	3.6	3	7
8932MCT	7932CT,… x A	6.3	3.0	4.4		
EL-02	RZM EL (*Rz* x sm.root)	4.7	2.4	4.5		
EL-04	RZM EL (*Rz* x sm.root)	5.0	2.6	4.4		
R827 (C27)	RZM R727A,B	5.3	2.5	4.7	3	7
R726 (C26)	RZM-ER R526, C26	5.8	2.8	4.6	3	6
US H11	LSS check	4.8	3.2	4.4		
Dorotea	Resist. check		3.3	3.7		
B4776R	Commercial check		3.3	5.4		
8835	7835aa x A		3.3	4.7		
8935	Inc. R776-89-5H13		3.0	4.2	3	7
8931	RZM 7931aa x A				3	7
CR711	RZM CR11(C)aa x A				3	7
CR712	6931aa x CR11(C)				3	7
R709-1	CR-RZM R509-1				3	7
C76-89-5	Inc. C76-89-5				3	7
Gabriela	Susc. check				6	8
LSD (.05)		1.0	1.2	0.7		
SP351069.0	LSS check	6.5				
(FC504 x FC502/2) x SP22-0		3.3				
From CBGA Coded Test						
Beta 4430R	Commercial hybrid			5.6		
US H11	Susc. check			4.2		
Mod. resist. check				3.3		
Mod. susc. check				4.8		
Susc. check				5.3		
Resist. check				2.8		

Ft. Collins: Test by L. Panella, USDA-ARS
Shakopee: Test by Betaseed run by M. Rekoske and J. Miller
Italy: Test by E. Biancardi, Rovigo, Italy
RR = root rot score (*Aphanomyces*)

TEST 299. EVALUATION OF BREEDING LINES AND POPULATIONS FOR NONBOLTING, SALINAS, CA., 1998-99

160 entries x 3 reps., sequential
1-row plots, 17.5 ft. long

Planted: November 3, 1998
Not planted for havest

Variety	Description	Stand Count Mean	Emergence Score 1/21	% Bolting 07/28	% Bolting 08/26	% Bolting 10/06	%Downy Mildew 05/26
Checks							
US H11	113102	26.0	4.0	14.0	18.8	20.0	21.3
SS-NB3	Spreckels, 1996	28.0	4.7	16.6	22.2	32.2	35.9
97-C37	Inc. U86-37	29.0	4.7	8.1	9.2	10.4	20.5
U86-37	Inc. C37	21.7	1.3	9.1	12.4	12.4	39.5
97-SP22-0	Inc. SP7622-0	27.7	4.7	81.8	78.2	62.4	44.8
97-US22/3	Inc. Y009 (US22/3)	28.3	4.7	88.3	93.0	56.2	28.1
97-US75	Inc. 268 (US75)	27.7	5.0	19.5	28.0	24.3	16.8
B4776R	Betaseed	28.0	4.7	22.0	36.2	50.2	34.3
Multigerm, open-pollinated lines							
R878% (Iso)	RZM R778%, (C78)	27.7	4.3	32.6	33.8	39.7	56.3
R778% (Iso)	RZM-ER-%S R578, R578/2, R578%	28.3	4.3	18.9	32.0	28.4	59.9
R778 (Iso)	RZM-ER R578, R578/2, R578%	30.3	4.7	17.3	22.8	23.8	42.0
R878 (Sp)	Inc. R778, R778%	28.3	3.3	27.0	28.2	31.7	54.5
R880	RZM R780, (C80)	28.3	4.7	22.2	25.7	26.1	31.0
R882 (Sp)	Inc. R781, R776, R781-43,… (C82)	28.3	4.7	30.7	31.0	34.3	54.9
R881 (Iso)	RZM R776, R781, R681,… (C82)	28.3	5.0	38.7	37.5	40.0	42.6
R776	RZM-ER R576 (C31*Rz*)	28.7	4.7	3.4	9.1	9.1	40.1
R781	RZM-ER R581	29.0	5.0	35.4	49.1	49.5	40.9
R770	RZM-ER R570	28.3	5.0	19.9	27.5	23.2	52.7
R879	RZM R779, (C79-1,*Rz*)	27.7	4.0	35.8	33.5	35.8	38.0
R736	RZM R636, (C79-8,R22)	26.7	4.3	51.4	61.4	62.6	17.1
R836	RZM R736, R743 (C79-8,R22)	30.3	5.0	45.4	56.3	44.2	26.2
R753	RZM R653	29.3	5.0	22.9	21.7	26.7	50.3
R853	RZM-ER-%S R653	29.3	5.0	23.1	28.7	27.2	33.0
R854	RZM R754	27.0	4.7	23.5	33.3	32.1	28.4

TEST 299. EVALUATION OF BREEDING LINES AND POPULATIONS FOR NONBOLTING, SALINAS, CA., 1998-99

(cont.)

Variety	Description	Stand Count Mean	Emergence Score 1/21	% Bolting 07/28	% Bolting 08/26	% Bolting 10/06	%Downy Mildew 05/26
Multigerm, open-pollinated lines (cont.)							
Y773 (Iso)	RZM Y673R	29.7	4.7	38.3	39.3	42.8	41.6
Y873	RZM-ER-%S Y673	29.0	5.0	42.9	32.2	30.9	41.9
Y873B	RZM Y773	28.3	5.0	49.6	52.8	50.4	33.0
R824	RZM R724,R725 (C79-2,-3)	29.0	5.0	32.6	42.7	38.5	39.6
R835	RZM R735 (C79-7,SES)	29.0	5.0	26.7	34.8	29.1	22.9
97-C37	Inc. U86-37	29.0	4.7	11.6	11.7	19.3	25.5
98-EL02	RZM 94-RM10-2,… (C80 x Smooth)	28.0	5.0	62.4	64.9	67.2	54.6
98-EL04	RZM 94-RM10-4,… (C80 x Smooth)	29.0	5.0	74.7	69.0	70.1	67.8
R876-89-5NB	RZM-%S R576-89-5NB	28.3	4.7	18.6	29.1	33.7	16.6
R876-89-5	RZM-%S R576-89-5 (C76-89-5)	10.0	0.7	25.4	67.5	65.2	4.8
Y866	RZM Y766	29.0	5.0	34.0	40.4	42.6	51.5
Y868	RZM Y768	28.3	5.0	24.0	41.5	35.5	44.5
Y769 (Iso)	RZM-ER Y569	28.0	5.0	45.5	60.9	49.2	48.5
Y869 (Iso)	RZM Y769 (C69)	27.3	5.0	31.7	41.5	42.8	50.3
Y869 (Sp)	Inc. Y769(C69)	28.0	5.0	32.1	36.9	42.9	22.6
Y767 (Iso)	RZM-ER Y567	28.0	4.7	42.6	60.7	57.6	46.9
Y867	RZM Y767 (C67)	26.7	4.3	48.8	62.1	58.0	32.0
Y871	RZM Y771	28.7	5.0	26.6	34.4	27.7	49.1
Y772 (Sp)	RZM Y672 x Y74(C)	28.0	4.7	34.0	36.4	32.9	36.2
Y872	RZM-%S Y672	28.7	4.7	14.8	23.0	28.8	41.2
Y872B	RZMY772 (C72)	29.0	4.7	25.1	28.6	28.4	46.0
Y875 (Iso)	RZM Y775	28.7	5.0	24.0	28.7	38.2	44.1
Y875 (Sp)	RZM Y775,Y773,Y772,Y767	27.0	4.3	28.3	33.2	31.9	34.4
R840	RZM R740 (C79-#s)	27.7	5.0	63.4	64.6	64.5	33.4
R826	RZM R726, (C26)	23.3	1.3	51.8	56.6	54.6	78.2
R827	RZM R727A,B, (C27)	29.3	5.0	37.5	67.0	69.3	51.1

TEST 299. EVALUATION OF BREEDING LINES AND POPULATIONS FOR NONBOLTING, SALINAS, CA., 1998-99

(cont.)

Variety	Description	Stand Count Mean	Emergence Score 1/21	% Bolting 07/28	% Bolting 08/26	% Bolting 10/06	%Downy Mildew 05/26
Multigerm, S^f,Aa populations & lines							
8926 (Iso)	RZM 7926 (A,aa)	29.0	5.0	24.2	33.4	39.2	43.8
8926 (Sp)	7931aa x RZM 7926	28.7	4.3	30.8	40.0	42.5	41.8
8927	RZM 7926aa x A	28.3	4.7	37.6	54.2	43.8	43.7
7931	6931aa x 931(C)	28.3	4.7	28.2	23.4	33.0	47.2
8931	RZM 7931aa x A, (popn-931)	29.0	5.0	20.7	25.3	26.4	32.2
8924	RZM 7924,…aa x 924(C)	27.0	4.7	43.2	45.7	46.9	33.3
Z831	RZM Z731,Z730aa x A	27.3	4.7	27.3	34.4	40.9	45.9
Z725	Z625-#(C)aa x Z31(C)	28.0	4.7	32.1	36.9	39.3	65.5
Z730	Z630-#(C)aa x Z31(C)	28.0	5.0	32.0	45.1	43.7	34.9
CR811	RZM CR711 (CR09/10)	28.3	5.0	35.3	45.9	50.5	27.1
CR812	RZM CR712	27.0	4.3	58.9	58.1	60.3	46.0
CR813	RZM CR713	27.7	4.7	52.9	65.2	65.5	49.4
R710	CR-RZM R509-#,R510-#(C)	28.0	4.7	54.7	56.1	56.0	39.2
R709-1	CR-RZM R509A-1	27.3	4.3	60.4	64.2	60.9	35.5
R709-9	CR-RZM R509A-9	27.0	4.7	28.9	37.9	41.5	32.7
R710-10	CR-RZM R509A-10	25.0	4.7	2.8	3.0	7.7	80.3
P811	RZM-PMR 6203-#,6208-#(C)	29.7	5.0	55.0	58.4	58.4	25.8
P812	RZM-PMR 6211-#,6217-#(C)	28.0	5.0	32.1	60.9	59.7	33.5
P813	Inc. 6201-#,6202-#(C), (CP01)	27.7	5.0	27.6	31.4	35.8	12.1
P814	Inc. 6205-#,6206-#(C), (CP02)	27.0	4.7	43.9	57.5	60.6	27.4
N730	Inc. N629,N630 (galls)	27.0	5.0	37.1	35.9	37.2	37.9
7932CT	Inc. 6260-#,…	26.7	4.7	16.4	27.7	33.8	42.3
8932	7932CT,7201,…aa x A	27.7	4.7	31.1	29.9	38.5	23.0
8932Am	Inc. 7932CT,7201…A	27.3	4.3	30.3	55.4	38.9	6.0
8932HO(M)	7204-7216CMS x A	27.7	4.7	35.9	60.5	47.5	14.4
8932H69	6869mmaa x A	28.0	5.0	40.5	52.4	51.2	22.6

TEST 299. EVALUATION OF BREEDING LINES AND POPULATIONS FOR NONBOLTING, SALINAS, CA., 1998-99

(cont.)

Variety	Description	Stand Count Mean	Emergence Score 1/21	% Bolting 07/28	% Bolting 08/26	% Bolting 10/06	%Downy Mildew 05/26
Multigerm, S^f,Aa populations & lines (cont.)							
8935 (Sp)	Inc. R776-89-5H13Aa	27.7	5.0	17.2	15.9	15.9	35.9
8935 (Iso)	RZM R776-89-5H13	27.3	4.7	19.5	23.3	28.0	35.4
8936	RZM R776-89-5H31	28.3	5.0	28.1	30.3	36.1	10.4
8937	RZM R776-89-5H11	29.7	5.0	15.1	23.7	28.6	21.2
8938	RZM Z731H11	28.3	4.7	12.9	34.3	18.8	41.2
8939	RZM Y769H31	28.3	5.0	15.4	26.1	34.2	48.3
Y869H31	7931aa x Y769	28.7	5.0	29.1	43.0	44.2	17.4
7933	Inc. 6264-#(C)	29.0	5.0	29.8	38.1	34.5	43.9
8913-70	RZM-ER-%S 6913-70, (C913-70)	30.0	4.7	5.8	12.5	9.2	70.4
8918-12	RZM-ER-%S 6918-12	27.0	4.3	28.6	37.3	38.5	40.7
8918-21	RZM 7918-21	27.7	3.7	14.4	21.8	15.6	8.4
8911-4-10M	RZM-ER-%S 6911-4-10	28.0	3.7	4.8	2.4	2.4	3.6
8925-19	Inc. 6925-19	27.3	4.0	12.3	9.6	10.7	50.3
Z825-6	Inc. Z625-6 (A,aa)	27.3	4.7	31.7	32.9	29.1	47.6
Z825-9	Inc. Z625-9 (A,aa)	28.7	4.0	14.0	27.8	32.3	15.2
Z830-11	Inc. Z630-11 (A,aa)	26.7	3.7	48.5	56.2	49.8	64.3
8929-41	Inc. 6929-41 (A,aa)	28.0	4.3	26.7	32.5	37.4	1.1
8929-72	Inc. 6929-72 (A,aa)	30.0	5.0	6.3	0.0	8.4	74.9
8929-102	Inc. 6929-102 (A,aa)	28.0	5.0	24.1	27.7	28.9	29.9
8929-112	Inc. 6929-112 (A,aa)	26.3	4.7	20.1	20.0	20.1	52.0
8929-114	Inc. 6929-114 (A,aa)	27.0	4.0	34.7	43.5	44.6	14.5
8929-115	Inc. 6929-115 (A,aa)	26.3	4.0	30.4	41.7	44.3	48.2
8929-133	Inc. 6929-133 (A,aa)	25.7	4.3	3.9	9.0	11.7	20.4
8929-153	Inc. 6929-153 (A,aa)	28.7	4.7	0.0	3.5	2.3	3.4
8929-154	Inc. 6929-154 (A,aa)	25.7	4.3	34.0	27.0	30.9	64.7

TEST 299. EVALUATION OF BREEDING LINES AND POPULATIONS FOR NONBOLTING, SALINAS, CA., 1998-99

(cont.)

Variety	Description	Stand Count Mean	Emergence Score 1/21	% Bolting 07/28	% Bolting 08/26	% Bolting 10/06	%Downy Mildew 05/26
Multigerm, S^f,Aa populations & lines (cont.)							
8930-19	Inc. 6930-19 (A,aa)	28.3	4.7	0.0	3.4	20.7	58.7
8930-39	Inc. 6930-39 (A,aa)	27.0	4.0	12.6	13.6	17.6	30.3
8930-102	Inc. 6930-102 (A,aa)	26.0	4.7	1.2	1.2	0.0	41.2
8927-29	Inc. 6927-29 (A,aa)	26.7	4.0	17.5	23.5	22.3	49.6
8927-30	Inc. 6927-30 (A,aa)	26.3	4.0	20.1	29.3	35.8	55.3
8927-33	Inc. 6927-33 (A,aa)	28.0	4.7	52.1	54.3	57.7	8.4
8927-37	Inc. 6927-37 (A,aa)	24.3	3.3	86.5	80.3	80.8	17.1
Monogerm, S^f,Aa populations & lines							
6546	Inc. F82-546, (C546)	27.3	4.0	20.7	20.6	30.6	12.5
6562	Inc. F82-562, (C562)	26.0	3.3	37.2	20.5	28.5	6.4
6718	Inc. U83-718, (C718)	26.0	3.3	3.6	7.4	6.0	17.7
6762-17	Inc. 0762-17,2762-17, (C762-17)	28.0	3.7	10.6	11.8	12.9	33.2
7835	6833,6833%,6834%aa x 835(C)	27.3	5.0	29.3	35.4	35.4	15.9
8835m	7835mmaa x A	27.7	5.0	21.5	28.5	38.3	10.9
8835M	7835Maa x A	27.3	5.0	25.6	29.3	32.9	14.7
8835HO	7835H50 x 7835	26.3	4.3	32.8	39.0	39.0	7.8
8835H50	C790-15CMS x 7835	28.0	4.7	14.0	22.5	29.7	8.3
7838	6828,6836,6837,…aa x 838(C)	28.3	5.0	31.8	36.3	40.9	24.5
8838m	7838mmaa x A	27.0	5.0	33.5	43.3	49.4	21.0
8838M	7838Maa x A	27.0	5.0	24.8	31.0	37.0	30.5
8838H11m	5911-4mmaa x 7838	25.0	3.7	17.2	18.9	20.1	15.6
8838HO(A)	7838H10 x 7838	27.3	4.3	23.1	28.9	28.8	14.7
8838HO(B)	7838H50 x 7838	27.7	4.0	16.8	19.2	24.1	13.2
8838H50	C790-15CMS x 7838	27.7	4.3	26.3	36.1	42.2	19.2
7869NB	NB-RZM 5869m(A,aa), (C869)	29.3	5.0	7.7	16.8	17.9	23.4
8869m	RZM 7869-#(C)m	28.0	4.7	25.1	24.9	29.7	21.4
8869HO	7869HO x RZM 7869-#(C),(C869CMS)	28.0	5.0	21.5	28.4	35.5	10.8
8890m	RZM 7890,6890,5890m (A,aa),(C890-1)	27.0	5.0	15.9	24.5	24.7	13.8

TEST 299. EVALUATION OF BREEDING LINES AND POPULATIONS FOR NONBOLTING, SALINAS, CA., 1998-99

(cont.)

Variety	Description	Stand Count Mean	Emergence Score 1/21	% Bolting 07/28	% Bolting 08/26	% Bolting 10/06	%Downy Mildew 05/26
Monogerm, S^f,Aa populations & lines (cont.)							
8890HO	7890HO x RZM 7890,…,(C890-1CMS)	26.0	4.7	30.6	41.9	43.8	6.6
8810m	RZM 7810NBm	25.0	4.0	13.6	12.2	14.9	21.2
8810M	RZM 7810NM	28.0	4.7	11.9	14.3	15.5	15.2
8848m	RZM 7848m (A,aa)	27.0	4.7	12.5	28.5	31.0	11.6
8848HOm	7848H88m x RZM 7848	26.7	4.3	29.9	34.7	33.6	8.6
8833	RZM, T-O 7833-#(C), 7834-#(C)	27.7	4.3	58.9	62.4	58.8	18.0
8833H50	C790-15CMS x 7833-#(C),7834-#(C)	28.0	5.0	48.9	58.5	49.7	8.2
8836	T-O 7836-#, 7837-#(C)	26.3	4.3	1.3	2.6	3.8	9.2
8836HOM	7838H10M x T-O 7836-#,7837-#	27.0	4.3	4.9	8.4	12.2	16.4
8829-3	Inc. 5829-3 (A,aa),(C829-3)	26.7	4.3	0.0	0.0	5.3	17.4
8829-3H50	C790-15CMS x 5829-3	27.3	4.7	0.0	3.6	6.0	17.1
8831-3	Inc. 5831-3 (A,aa),(C831-3)	25.7	4.0	3.8	2.6	3.8	34.9
8831-3H50	C790-15CMS x 5831-3	29.0	5.0	20.9	26.1	25.1	25.6
8831-4	T-O 7831-4-#(C) (A,aa),(C831-4)	28.0	4.7	0.0	0.0	9.7	19.1
8831-4HO	8131-4HOM x 7831-4-#(C)	27.3	4.7	1.3	1.3	2.5	13.4
8833-5	Inc.5833-5 (A,aa),(C833-5)	29.0	4.3	19.5	24.2	26.5	20.7
8833-5H50	C790-15CMS x 5833-5	27.3	4.7	13.5	17.8	21.8	27.8
8833-12	Inc. 5833-12 (A,aa),(C833-12)	27.3	4.3	45.9	44.6	41.9	56.1
8833-12H50	C790-15CMS x 5833-12	27.0	5.0	41.3	54.3	65.5	13.3
8911-4-7	STO 7911-4-7-#(C),(C911-4-7)	25.3	3.3	46.4	44.7	40.1	50.8
8911-4-7H50	6911-4-7HO x 7911-4-7-#(C)	26.3	4.0	42.9	39.5	39.0	45.8
8818-1(C)	Inc. 6818-1mm (A,aa)	24.0	2.0	5.6	5.4	8.2	14.1
8818-2(C)	Inc. 6818-2mm (A,aa)	26.3	3.0	2.5	6.4	6.4	11.4
8818-6(C)	Inc. 6818-6mm (A,aa)	25.7	3.0	0.0	4.1	5.4	24.5
8818-11(C)	Inc. 6818-11mm (A,aa)	21.3	2.0	7.7	6.1	9.2	6.3
8818-12(C)	Inc. 6818-12mm (A,aa)	25.7	4.0	6.0	11.5	18.1	17.7

TEST 299. EVALUATION OF BREEDING LINES AND POPULATIONS FOR NONBOLTING, SALINAS, CA., 1998-99

(cont.)

Variety	Description	Stand Count Mean	Emergence Score 1/21	% Bolting 07/28	% Bolting 08/26	% Bolting 10/06	%Downy Mildew 05/26
Monogerm, S^f,Aa populations & lines (cont.)							
8818-21(C)	Inc. 6818-21mm (A,aa)	25.0	2.7	0.0	0.0	0.0	6.8
8818-1B	Inc. 6818B-1	26.7	4.3	26.1	25.0	24.8	13.4
8818-1BHO	C790-15CMS x 6818B-1	28.0	5.0	27.1	42.7	49.5	9.6
8818-2B	Inc. 6818B-2	27.0	4.0	17.4	18.6	31.9	49.5
8818-2BHO	C790-15CMS x 6818B-2	0.7	0.0		no plants		
F92-790-15	Inc. 1790-5 (C790-15)(921194)	27.0	3.3	38.3	48.2	45.5	10.0
Mean		27.3	4.4	27.4	33.1	34.1	31.8
LSD (.05)		2.7	0.8	17.3	17.3	18.5	19.8
C.V. (%)		6.1	11.1	39.3	32.6	33.7	38.8
F value		9.0**	8.0**	8.7**	10.1**	7.3**	6.7**

NOTES: Bolting tests were planted earlier than in previous years to get greater induction. In addition, the winter-spring of 1999 was colder than normal. Much higher levels of bolting were experienced than for a number of years. Downy mildew (*Peronospora farinosa*) appeared in early spring and by mid-summer became severe. Downy mildew affected plant growth and survival and probably rate and percent bolting. Counts were made based upon obvious top symptoms. *Sclerotium rolfsii* (southern root rot) also became severe in this planting. Due to plant death and rotting, bolting counts later in the season were difficult to accurately make. Due to severity of bolting and diseases, the second bolting counts (8/26/99) are probably the most accurate and show the best differential levels between entries.

TEST 199. EVALUATION OF TESTCROSS HYBRIDS FOR NONBOLTING, SALINAS, 1998-99

80 entries x 3 reps., sequential
1-row plots, 17.5 ft. long

Planted: November 3, 1998
Not harvested for yield

Variety	Description	Stand Count	Emergence Score	% Bolting			%Downy Mildew
		Mean	1/21	07/28	08/26	10/06	05/26
US H11	113102	28.3	4.7	13.2	19.0	15.5	18.6
SS-NB3	Spreckels, 1996	31.3	5.0	16.1	24.3	24.2	24.0
B4776R	Betaseed 4776R.7653 (3-27-98)	30.7	5.0	31.6	46.9	43.6	26.2
B4035R	Betaseed 4035R (7-10-97)	30.0	5.0	40.0	52.3	51.2	27.0
Rizor	Holly HH108, 9-3-97	31.0	5.0	60.2	73.7	58.3	37.2
Rifle	Holly, 9-16-98	29.3	5.0	49.0	58.0	64.8	31.7
SS-778R	Spreckels, X782402	27.7	5.0	38.5	56.6	57.8	33.6
5KJ0142	Betaseed (8-18-97)	28.3	4.7	30.5	49.3	44.6	46.1
R878%H50 (Iso)	C790-15CMS x RZM R778%	29.7	5.0	33.9	45.0	46.2	13.4
R878H50 (Sp)	C790-15CMS x R778,%	29.0	4.0	27.6	43.1	38.2	39.3
R878H69	7869aa x R778,%	28.3	4.0	29.2	31.6	34.0	13.9
R878H55	7835H50 x R778,%	29.3	3.7	24.9	35.1	27.2	26.9
R878H58	7838H50 x R778,%	29.0	3.7	24.6	34.7	35.7	24.0
R876-89-5NBH50	C790-15CMS x RZM-%S R576-89-5NB	28.0	4.0	19.9	26.0	27.1	9.7
R876-89-5H50	C790-15CMS x RZM-%S R576-89-5	28.7	5.0	20.9	32.5	36.0	8.1
Y882H50	C790-15CMS x R781,R776,…	28.7	4.7	26.6	32.5	31.5	19.0
Y882H37	4807HO x R781,R776,…	28.7	5.0	19.7	39.4	43.9	11.7
Y882H27	6831-4HO x R781,R776,…	27.0	4.0	21.3	30.0	27.6	31.4
Y882H38m	7838mmaa x R781,R776,…	26.7	4.7	30.1	40.0	51.2	21.3
Y875H50(Iso)	C790-15CMS x RZM Y775	29.0	5.0	28.7	35.6	34.5	23.0
Y875H50(Sp)	C790-15CMS x RZM Y775,…	28.7	4.7	17.4	23.2	24.4	22.2
Y875H37	4807HO x RZM Y775,…	28.7	5.0	38.2	56.5	53.1	23.5
Y875H27	6831-4HO x RZM Y775,…	28.0	4.7	13.1	24.9	22.6	16.8
Y868H50	C790-15CMS x RZM Y678	30.3	5.0	11.0	24.2	23.0	23.2

TEST 199. EVALUATION OF TESTCROSS HYBRIDS FOR NONBOLTING, SALINAS, 1998-99

(cont.)

Variety	Description	Stand Count Mean	Emergence Score 1/21	% Bolting 07/28	% Bolting 08/26	% Bolting 10/06	%Downy Mildew 05/26
Y866H50	C790-15CMS x RZM Y766	29.7	5.0	26.1	43.1	46.7	28.3
Y867H50	C790-15CMS x RZM Y767(C67)	29.7	5.0	25.6	45.7	45.9	15.9
Y871H50	C790-15CMS x RZM Y771	29.0	5.0	26.2	47.0	48.2	24.1
Y872H50	C790-15CMS x RZM-%S Y672	29.3	5.0	13.6	30.6	36.2	29.9
Y872H50	C790-15CMS x RZM Y772 (C72)	28.7	4.7	31.4	50.1	52.4	22.2
Y869H50	C790-15CMS x Y769	28.3	4.7	30.2	38.6	41.9	18.0
R879H50	C790-15CMS x RZM R779	28.7	5.0	28.0	38.4	36.1	18.6
R836H50	C790-15CMS x RZM R736	27.7	5.0	32.5	51.1	42.4	19.3
R854H50	C790-15CMS x RZM R754	28.0	5.0	32.1	41.7	39.4	13.2
R873BH50	C790-15CMS x RZM Y773	30.3	5.0	31.1	43.0	38.6	20.9
R835H50	C790-15CMS x RZM R735	29.0	5.0	28.8	45.7	51.4	23.1
8931H50	C790-15CMS x RZM 7931	28.3	5.0	11.9	23.6	23.7	19.7
8931H46	7869-6HO x RZM 7931	28.3	4.3	21.0	37.6	35.3	16.5
8931H38m	7838mmaa x RZM 7931	28.7	4.7	12.9	17.6	28.3	25.7
8924H50	C790-15CMS x RZM 7924	28.3	5.0	23.7	37.8	33.0	15.2
Z831H50	C790-15CMS x RZM Z730,Z731	29.0	5.0	32.0	35.5	37.7	20.9
Z831H37	4807HO x RZM Z730,Z731	26.7	4.3	19.7	32.3	40.2	20.5
CR812H50	C790-15CMS x RZM CR712	28.7	5.0	47.7	60.3	59.1	25.7
CR813H50	C790-15CMS x RZM CR713	27.7	4.7	33.8	56.4	58.9	21.8
8926H50(Iso)	C790-15CMS x RZM 7926	28.0	5.0	23.7	41.9	35.8	18.6
8926H50(Sp)	C790-15CMS x RZM 7926	27.7	5.0	30.6	46.3	39.8	17.4
8926H37	4807HO x RZM 7926	27.7	4.7	31.3	46.7	40.2	37.7
8932H50	C790-15CMS x 7932CT,7201…	28.3	4.7	34.3	48.4	37.7	19.9
8932H38m	7838mmaa x 7932CT,7201…	29.7	4.7	43.9	50.7	48.4	30.2

TEST 199. EVALUATION OF TESTCROSS HYBRIDS FOR NONBOLTING, SALINAS, 1998-99

(cont.)

Variety	Description	Stand Count Mean	Emergence Score 1/21	% Bolting 07/28	% Bolting 08/26	% Bolting 10/06	%Downy Mildew 05/26
8935H50(Iso)	C790-15CMS x RZM R776-89-4H13	29.3	4.7	16.1	33.0	36.3	20.0
8935H50(Sp)	C790-15CMS x R776-89-5H13	28.7	5.0	13.8	26.6	25.6	31.0
8935H37	4807HO x R776-89-5H13	28.0	5.0	16.5	33.2	40.8	34.8
8935H38m	7838mmaa x R776-89-5H13	28.0	4.0	24.8	40.5	33.2	21.1
8936H50	C790-15CMS x RZM R776-89-5H31	28.3	5.0	15.3	32.8	25.9	16.7
8937H50	C790-15CMS x RZM R776-89-5H11	29.3	5.0	20.5	26.1	28.4	16.1
8938H50	C790-15CMS x RZM Z731H11	28.3	4.7	21.0	30.5	29.4	34.4
8939H50	C790-15CMS x RZM Y769H31	28.7	5.0	32.6	51.7	51.4	29.9
8913-70H50	C790-15CMS x RZM-ER-%S 6913-70	29.3	5.0	19.6	33.1	28.7	31.6
8918-12H50	C790-15CMS x RZM-ER-%S 6918-12	28.0	4.7	22.7	50.0	56.8	18.1
8918-21H50	C790-15CMS x RZM 7918-21	28.7	4.7	27.8	38.0	44.7	17.5
8911-4-10H50	C790-15CMS x RZM-ER-%S 6911-4-10	29.0	5.0	6.9	16.3	18.5	4.6
8925-19H50	C790-15CMS x 6925-19	30.0	5.0	12.3	28.1	29.2	23.2
8929-41H50	C790-15CMS x 6929-41	29.7	5.0	25.6	48.8	48.9	11.5
8929-72H50	C790-15CMS x 6929-72	29.3	5.0	1.1	1.1	3.4	39.7
8929-102H50	C790-15CMS x 6929-102	30.0	5.0	42.5	54.7	57.0	14.5
8929-112H50	C790-15CMS x 6929-112	29.7	5.0	36.0	40.6	41.6	19.0
8929-114H50	C790-15CMS x 6929-114	30.0	5.0	23.3	45.6	45.6	24.4
8929-115H50	C790-15CMS x 6929-115	30.0	5.0	24.9	33.4	38.6	19.2
8929-133H50	C790-15CMS x 6929-133	28.3	5.0	11.7	18.8	20.0	3.5
8929-153H50	C790-15CMS x 6929-153	29.3	5.0	3.5	4.6	4.6	13.8
8929-154H50	C790-15CMS x 6929-154	28.7	5.0	16.9	33.5	31.0	46.8
8930-19H50	C790-15CMS x 6930-19	29.0	5.0	8.0	18.2	16.0	25.7
8930-39H50	C790-15CMS x 6930-39	30.0	5.0	10.0	17.8	22.2	13.3
8930-102H50	C790-15CMS x 6930-102	30.0	5.0	6.7	6.7	8.9	27.8
8927-29H50	C790-15CMS x 6927-29	29.7	5.0	27.0	43.9	49.5	43.8
8927-30H50	C790-15CMS x 6927-30	28.0	5.0	25.0	39.3	40.5	33.3
8927-33H50	C790-15CMS x 6927-33	29.3	5.0	46.4	52.1	53.2	25.1

TEST 199. EVALUATION OF TESTCROSS HYBRIDS FOR NONBOLTING, SALINAS, 1998-99

(cont.)

Variety	Description	Stand Count Mean	Emergence Score 1/21	% Bolting 07/28	% Bolting 08/26	% Bolting 10/06	%Downy Mildew 05/26
8927-37H50	C790-15CMS x 6927-37	28.3	5.0	61.4	76.7	71.8	26.0
Z825-6H50	C790-15CMS x Z625-6	29.3	4.7	30.7	51.0	57.8	28.5
Z825-9H50	C790-15CMS x Z625-9	29.0	5.0	28.7	52.9	50.5	32.1
Z830-11H50	C790-15CMS x Z630-11	29.0	5.0	41.5	56.3	49.5	49.6
Mean		28.9	4.8	25.7	38.5	38.4	23.7
LSD (.05)		2.3	0.5	14.2	15.5	16.5	18.9
C.V. (%)		5.0	6.3	34.2	25.0	26.6	49.5
F value		1.2NS	3.6**	5.3**	6.5**	5.3**	1.9**

Notes: See notes for Test 299. In general for % bolting and % downy mildew infection, there is good correspondence between the line (Test 199) and its hybrid. Particularly for downy mildew, lines with high resistance produced hybrids with moderate resistance. For some lines and hybrids, the relationship for bolting was less clear cut.

TEST 999. EVALUATION OF TOPCROSS HYBRIDS FOR NONBOLTING, SALINAS, 1998-99

96 entries x 3 reps., sequential
1-row plots, 11 ft. long

Planted: November 3, 1998
Not harvested for yield

Variety	Description	Stand Count	Emergence Score	% Bolting			%Downy Mildew
		Mean	1/21	07/28	08/26	10/06	05/26
Checks							
SS-NB3	Spreckels, 1996	17.0	5.0	11.8	23.5	25.5	7.8
US H11	113102	17.3	4.7	7.5	19.0	17.1	5.7
Y869 (Iso)	RZM Y769 (C69)	15.3	4.0	28.0	50.0	49.7	7.1
Y869 (Sp)	Inc. Y769 (C69)	17.0	4.0	25.6	35.6	37.5	9.7
Y869H37	4807HO (C306/2) x Y769	16.7	4.7	24.6	30.5	38.5	5.9
Y869H50	C790-15CMS x Y769	16.7	4.3	36.4	54.5	52.5	6.0
Population Hybrids							
Y869H35m	7835mmaa x Y769	15.0	4.0	42.2	46.7	48.9	15.6
Y869H38m	7838mmaa x Y769	14.3	3.7	28.4	38.5	38.5	0.0
Y869H69	7869mmaa x Y769	16.0	4.3	29.1	39.7	48.2	14.9
Y869H31	7931aa x Y769	15.7	4.7	25.6	23.6	27.6	11.0
Y869H30M	7932CTMaa x Y769	14.7	4.0	29.2	36.8	36.8	8.3
Y869H32	7204-7216CMS x Y769	15.3	4.3	34.9	43.5	45.8	17.2
Y869H88	7890HO x Y769	16.3	4.3	22.7	24.9	31.0	14.8
Y869H70	7869HO x Y769	16.3	4.7	22.4	28.3	30.5	18.3
Y869H55m	7835H50m x Y769	15.7	4.3	19.2	42.4	44.4	12.8
Y869H58m	7838H50m x Y769	16.0	4.7	31.5	32.9	39.4	12.3
Y869H59m	7838H10m x Y769	16.7	4.3	29.9	36.0	38.0	5.9
Y869H49m	7848H88m x Y769	16.7	4.3	38.1	56.3	54.2	12.5
Testcross Hybrids							
Y869H5	C833- 5aa x Y769	16.0	4.3	14.9	23.2	23.2	34.2
Y869H12	C833-12aa x Y769	14.7	4.0	36.5	61.7	59.4	9.0
Y869H29	C829-3aa x Y769	15.7	4.3	8.5	14.7	16.8	0.0
Y869H4	C831-3aa x Y769	12.0	2.7	44.1	41.5	44.9	24.6
Y869H27	C831-4HO x Y769	15.3	4.0	8.6	8.5	15.3	15.6
Y869H7	C911-4-7HO x Y769	16.3	4.0	38.8	34.4	46.1	20.7

TEST 999. EVALUATION OF TOPCROSS HYBRIDS FOR NONBOLTING, SALINAS, 1998-99

(cont.)

Variety	Description	Stand Count Mean	Emergence Score 1/21	% Bolting 07/28	% Bolting 08/26	% Bolting 10/06	%Downy Mildew 05/26
Testcross Hybrids (cont.)							
Y869H46	7869-6HO x Y769	15.7	3.7	23.2	34.6	44.6	22.8
Y869H45	C867-1HO x Y769	16.0	4.0	46.9	63.0	63.5	34.8
Y869H17	7817HO x Y769	15.0	3.7	17.8	17.8	15.6	6.7
Y869H18	7818HO x Y769	16.7	4.7	23.8	27.9	34.1	20.1
Y869H19	7818H50 x Y769	16.3	4.3	22.7	32.7	30.6	10.4
Y869H20	7818-4H50 x Y769	15.7	4.0	13.3	23.7	32.3	21.7
Y869H21	7818-14H50 x Y769	16.0	4.7	21.4	38.0	44.3	15.3
Y869H22	7818-22H50 x Y769	15.3	4.3	17.2	17.2	27.9	19.6
Y869H23	7818-23H50 x Y769	15.7	5.0	25.6	36.0	33.6	16.9
Topcross hybrids onto 818-#s							
Y869H15-1B	6818-1Baa x Y769	15.3	4.3	24.4	37.5	28.6	4.8
Y869H15-2B	6818-2Baa x Y769	16.0	4.3	14.6	20.4	16.5	5.9
Y869H15-1	6818-1aa x Y769	16.7	4.0	16.2	30.1	34.0	18.5
Y869H15-2	6818-2aa x Y769	15.3	4.0	6.3	18.8	25.3	32.1
Y869H15-6	6818-6aa x Y769	16.0	4.3	6.3	4.2	6.3	18.6
Y869H15-21	6818-21aa x Y769	13.3	3.0	2.6	9.2	14.8	21.6
Topcross hybrids onto 808-#s							
Y869H9 - 1	7808- 1aa x Y769	14.0	3.3	35.5	45.0	50.0	4.6
- 2	7808- 2aa x Y769	13.7	3.3	33.7	61.7	61.2	14.3
- 3	7808- 3aa x Y769	14.3	3.7	21.5	19.3	24.9	0.0
- 4	7808- 4aa x Y769	15.0	4.0	17.4	21.3	25.3	16.0
- 7	7808- 7aa x Y769	15.3	4.0	6.5	10.8	15.1	8.6
- 8	7808- 8aa x Y769	15.7	4.0	10.4	14.8	24.4	0.0
- 9	7808- 9aa x Y769	15.7	4.0	18.5	37.7	35.8	16.4

TEST 999. EVALUATION OF TOPCROSS HYBRIDS FOR NONBOLTING, SALINAS, 1998-99

(cont.)

Variety	Description	Stand Count Mean	Emergence Score 1/21	% Bolting 07/28	% Bolting 08/26	% Bolting 10/06	%Downy Mildew 05/26
Topcross hybrids onto 808-#s (cont.)							
-12	7808-12aa x Y769	15.3	4.7	32.5	45.4	51.5	13.1
-13	7808-13aa x Y769	15.0	4.0	18.3	30.6	31.3	3.9
-16	7808-16aa x Y769	14.3	3.7	19.1	26.2	35.7	4.4
Topcross hybrids onto popn-869-#s							
Y869H69 - 1	7869- 1aa x Y769	16.7	4.0	40.3	53.9	50.0	20.1
- 2	7869- 2aa x Y769	16.3	4.3	39.1	59.7	59.7	4.0
- 4	7869- 4aa x Y769	14.3	4.0	55.9	67.5	67.5	9.5
- 5	7869- 5aa x Y769	14.7	3.7	38.7	49.5	45.3	18.7
- 6	7869- 6aa x Y769	15.0	4.3	17.5	26.3	29.3	19.9
- 7	7869- 7aa x Y769	15.7	4.0	12.8	17.1	25.6	2.1
-13	7869-13aa x Y769	16.0	4.3	27.7	35.7	37.6	2.2
-19	7869-19aa x Y769	16.3	4.7	22.7	49.6	45.3	12.5
-20	7869-20aa x Y769	15.7	4.3	26.4	30.7	36.7	22.6
-20B	7869-20Baa x Y769	14.3	4.3	25.7	39.7	39.5	14.1
-24	7869-24aa x Y769	17.0	5.0	33.1	44.7	40.8	15.7
Topcross hybridsonto popn-833-#s							
Y869H33 - 1	7833- 1aa x Y769	15.3	4.7	45.5	53.8	64.3	10.3
- 3	7833- 3aa x Y769	13.7	4.0	54.4	71.3	71.3	10.3
-10	7833-10aa x Y769	16.7	4.7	22.5	32.6	28.5	10.2
-11	7833-11aa x Y769	17.0	4.3	26.7	32.6	30.7	15.9
-12	7833-12aa x Y769	15.0	3.7	49.0	64.0	66.7	2.1
Topcross hybrids onto popn-834-#s							
Y869H34 - 1	7834- 1aa x Y769	16.7	4.3	25.9	18.8	22.0	3.7
- 2	7834- 2aa x Y769	15.3	4.3	43.8	56.8	58.9	13.2
- 3	7834- 3aa x Y769	15.0	3.7	31.5	29.0	33.7	23.4
- 5	7834- 5aa x Y769	16.7	4.3	46.5	62.0	47.7	19.7
- 8	7834- 8aa x Y769	14.7	3.7	51.8	65.2	60.4	21.1

TEST 999. EVALUATION OF TOPCROSS HYBRIDS FOR NONBOLTING, SALINAS, 1998-99

(cont.)

Variety	Description	Stand Count Mean	Emergence Score 1/21	% Bolting 07/28	% Bolting 08/26	% Bolting 10/06	%Downy Mildew 05/26
Topcross hybrids onto popn-828-#s							
Y869H28 - 9	7828- 9aa x Y769	15.7	4.3	12.6	18.9	25.3	8.8
-10	7828-10aa x Y769	17.0	4.3	13.7	21.6	23.5	3.9
Topcross hybrids onto popn-831-4-#s							
Y869H27 - 1	7831-4- 1aa x Y769	15.7	3.0	13.0	22.9	25.2	14.7
- 2	7831-4- 2aa x Y769	15.0	3.0	26.7	31.1	42.2	11.1
- 7	7831-4- 7aa x Y769	14.7	4.0	11.3	7.0	11.6	6.8
- 8	7831-4- 8aa x Y769	15.7	4.0	19.2	23.2	25.5	23.3
- 9	7831-4- 9aa x Y869	14.0	3.0	10.6	10.6	7.8	9.4
-10	7831-4-10aa x Y769	14.3	3.3	23.7	28.3	40.2	7.1
Topcross hybrids onto popn-836-#s							
Y869H36 - 3	7836- 3aa x Y769	12.7	3.0	21.7	34.3	45.1	9.9
-10	7836-10aa x Y769	15.3	3.7	35.1	43.8	55.1	2.1
-11	7836-11aa x Y769	14.3	3.0	32.7	49.2	55.9	16.0
-14	7836-14aa x Y769	13.7	3.0	22.5	29.9	39.6	14.6
Topcross hybrids onto popn-837-#s							
Y869H77 - 1	7837- 1aa x Y769	13.7	3.0	19.8	27.5	19.8	13.3
- 1B	7837- 1Baa x Y769	14.3	3.0	27.9	25.4	30.0	14.0
- 2	7837- 2aa x Y769	16.3	4.0	33.0	45.2	47.3	2.1
- 3	7837- 3aa x Y769	16.0	5.0	37.5	54.2	56.3	4.2
- 4	7837- 4aa xY769	14.7	3.0	44.2	55.6	62.1	2.6
Topcross hybrids onto popn-839-#							
Y869H79 - 1	7839- 1aa x Y769	16.3	4.7	33.2	43.8	48.0	12.5
- 2	7839- 2aa x Y769	16.3	4.0	42.7	50.5	48.1	2.1
- 3	7839- 3aa x Y769	16.0	4.3	35.7	39.9	35.8	18.6
- 4	7839- 4aa x Y769	15.3	4.3	27.7	41.4	49.7	10.4

TEST 999. EVALUATION OF TOPCROSS HYBRIDS FOR NONBOLTING, SALINAS, 1998-99

(cont.)

Variety	Description	Stand Count Mean	Emergence Score 1/21	% Bolting 07/28	% Bolting 08/26	% Bolting 10/06	%Downy Mildew 05/26
Topcross hybrids onto popn-839-# (cont.)							
Y869H79 - 5	7839- 5aa x Y769	16.0	4.3	39.5	54.2	56.3	8.5
- 5B	7839- 5Baa x Y769	13.3	3.7	50.4	52.0	60.4	7.6
- 6	7839- 6aa x Y769	15.3	3.7	26.3	26.3	30.7	14.6
-10	7839-10aa x Y769	15.3	4.3	26.3	30.6	26.3	11.0
B4776R	Betaseed, 3-27-98	15.0	3.7	40.7	55.9	61.2	2.2
Mean		15.4	4.0	27.1	36.0	38.6	12.1
LSD (.05)		1.9	0.8	18.0	22.7	23.2	19.1
C.V. (%)		7.6	12.8	41.3	39.2	37.4	97.7
F value		2.4**	3.2**	3.5**	3.7**	3.2**	1.2NS

NOTES: See notes for tests 199 and 299.

EVALUATION OF EXPERIMENTAL HYBRIDS, SALINAS and IMPERIAL VALLEY, CA., 1998-99

(TESTS 199, 299, 2699, 3599, 5899, B399 and B899)

	Test 2699 (yield)			Test 199 (NB-Hyb)		Test 299 (NB-Line)		Test 3599 (PM-ERR)	
Variety	Sugar Yield	Sucrose	RJAP	Bolting	DM	Bolting	DM	Powdery Mildew	ERR-DI
	lbs	%	%	%	%	%	%	%	%
Experimental hybrids with S_1 pollinators									
SS-432R	12922	16.40	84.0					6.6	2.9
Rifle	14374	17.29	83.9	58.0	31.7			7.6	17.8
B4776R	14911	18.02	85.7	46.9	26.2	36.2	34.3	7.1	18.6
8931H50	13288	16.24	83.6	23.6	19.7	25.3	32.2		
8925-19H50	14773	16.24	85.3	28.1	23.2	9.6	50.3	6.1	5.6
8913-70H50	13953	16.74	83.1	33.1	31.6	12.5	70.4	6.6	0.1
8911-4-10H50	14840	17.13	81.5	16.3	4.6	2.4	3.6		
8918-12H50	14342	15.96	84.1	50.0	18.1	37.3	40.7	4.7	1.3
8918-21H50	14145	16.01	85.1	38.0	17.5	21.8	8.4	5.8	2.9
Z825-6H50	15069	16.79	83.2	51.0	28.5	32.9	47.6	7.3	3.6
Z825-9H50	15044	18.21	85.1	52.9	32.1	27.8	15.2	5.3	23.8
Z830-11H50	14709	16.23	84.1	56.3	49.6	56.2	64.3	4.6	7.9
R709-1H50	14377	16.96	83.4						
CR812H50	13510	16.16	83.9	60.3	25.7	58.1	46.0		
CR813H50	14182	16.10	84.9	56.4	21.8	65.2	49.4		
R709-9H50	14706	15.86	85.8						
S_1 pollinators from MM,VY,S^f,Aa,*Rz* popns									
R878H50	13129	16.41	83.8	43.1	39.3	28.2	54.5		
8930-19H50	14744	16.81	84.6	18.2	25.7	3.4	58.7	5.7	6.3
8930-39H50	14356	16.30	84.5	17.8	13.3	13.6	30.3	5.5	7.6
8930-102H50	14107	16.64	83.1	6.7	27.8	1.2	41.2	7.1	1.5
R882H50	14106	15.96	84.7	32.5	19.0	31.0	54.9		
R876-89-5H50	14662	16.49	84.3	32.5	8.1	67.5	4.8		

EVALUATION OF EXPERIMENTAL HYBRIDS, SALINAS and IMPERIAL VALLEY, CA., 1998-99

(TESTS 199, 299, 2699, 3599, 5899, B399 and B899)

(cont.)

Variety	Test 2699 (yield) Sugar Yield	Sucrose	RJAP	Test 199 (NB-Hyb) Bolting	DM	Test 299 (NB-Line) Bolting	DM	Test 3599 (PM-ERR) Powdery Mildew	ERR-DI
	lbs	%	%	%	%	%	%	%	%
S_1 pollinators from MM,VY,S^f,Aa,Rz popns (cont.)									
8929-41H50	14523	16.65	84.1	48.8	11.5	32.5	1.1	5.1	3.7
8929-72H50	14082	16.25	84.8	1.1	39.7	0.0	74.9	5.0	14.9
8929-102H50	14039	16.39	83.5	54.7	14.5	27.7	29.9	5.6	0.3
8929-112H50	14236	17.14	83.6	40.6	19.0	20.0	52.0	6.3	0.7
8929-114H50	14985	16.63	84.3	45.6	24.4	43.5	14.5	5.5	20.8
8929-115H50	13970	17.08	84.0	33.4	19.2	41.7	48.2	5.3	8.4
8929-133H50	12993	16.56	84.3	18.8	3.5	9.0	20.4	6.2	9.2
8929-153H50	13639	16.34	84.6	4.6	13.8	3.5	3.4	6.1	0.6
8929-154H50	15489	16.68	83.8	33.5	46.8	27.0	64.7	4.9	1.0
8924H50	14137	16.65	84.3	37.8	15.2	45.7	33.3		
Lines & S_1 pollinators from MM,S^f,Aa,R22 popns									
4035R	13763	16.27	84.0	52.3	27.0			7.0	18.6
Rizor	14558	17.20	84.5	73.7	37.2			7.1	10.5
Y869H50	14284	16.33	84.7	38.6	18.0	41.5	50.3(Iso)	36.9	22.6
						36.9	22.6(Sp)		
R835H50	13128	16.20	84.1	45.7	23.1				
R836H50	13232	15.79	83.8	51.1	19.3	56.3	26.2		
Y873BH50	12854	15.79	84.5	43.0	20.9	52.8	33.0		
R879H50	12679	15.23	84.4	38.4	18.6	33.5	38.0		
Y867H50	13724	16.06	85.0	45.7	15.9	62.1	32.0		
Y872H50	13762	15.90	83.8	30.6	29.9	23.0	41.2		
Y875H50	12596	15.85	85.2	23.2	22.2	33.2	34.4		
8926H50 (Sp)	13847	16.24	83.3	46.3	17.4	40.0	41.8		
8926H50 (Iso)	13306	15.86	84.0	41.9	18.6	33.4	43.8		

EVALUATION OF EXPERIMENTAL HYBRIDS, SALINAS and IMPERIAL VALLEY, CA., 1998-99

(TESTS 199, 299, 2699, 3599, 5899, B399 and B899)

(cont.)

Variety	Test 2699 (yield) Sugar Yield			Test 199 (NB-Hyb)		Test 299 (NB-Line)		Test 3599 (PM-ERR) Powdery Mildew	
	Sugar Yield	Sucrose	RJAP	Bolting	DM	Bolting	DM	Powdery Mildew	ERR-DI
	lbs	%	%	%	%	%	%	%	%
Lines & S_1 pollinators from MM,S^f,Aa,R22 popns (cont.)									
8927-29H50	14514	16.91	83.9	43.9	43.8	23.5	49.6	5.3	1.3
8927-30H50	13105	16.15	82.1	39.3	33.3	29.3	55.3	5.8	5.7
8927-33H50	13770	16.55	83.8	52.1	25.1	54.3	8.4	6.4	0.6
8927-37H50	14542	16.27	85.2	76.7	26.0	80.3	17.1	6.8	5.8
Mean	14041.7	16.46	84.2	38.5	23.7	33.1	31.8	6.5	13.5
LSD (.05)	1321.4	0.62	1.6	15.5	18.9	17.3	19.8	0.6	8.9
C.V.(%)	9.6	3.84	2.0	25.0	49.5	32.6	38.8	6.1	40.6
F value	2.2**	6.17**	2.0**	6.5**	1.9**	10.1**	6.7**	25.5**	40.3**

EVALUATION OF EXPERIMENTAL HYBRIDS, SALINAS and IMPERIAL VALLEY, CA., 1998-99

(TESTS 199, 299, 2699, 3599, 5899, B399 and B899)

(cont.)

Variety	Test 5899 (Rzm) Sugar Yield lbs	Sucrose %	RJAP %	Test B399 (IV-Line) Sugar Yield lbs	Sucrose %	Bolting %	Test B899 (IV-Hyb) Sugar Yield lbs	Sucrose %	Bolting %
Experimental hybrids with S_1 pollinators									
SS-432R	7983	17.73	84.1						
Rifle	8501	18.40	85.9	11859	15.18	2.1	8270	13.35	0.0
B4776R	10973	18.25	87.8	11034	15.49	0.0	9240	13.99	0.0
8931H50	8323	16.45	82.7	11693	14.69	0.3	7363	12.09	0.0
8925-19H50	10653	17.70	87.0	12336	14.05	0.0	9372	12.55	0.0
8913-70H50	9685	17.63	85.2	9788	13.44	3.4	8547	13.56	0.0
8911-4-10H50	10118	18.08	83.7	10089	15.38	0.8	7150	12.76	0.0
8918-12H50	9651	17.83	88.1	10975	14.36	1.9	9286	12.53	0.0
8918-21H50	7672	17.00	86.8	10018	15.38	0.0	6099	13.05	0.0
Z825-6H50	8299	17.50	87.0	12388	14.99	1.9	8705	12.81	1.6
Z825-9H50	10250	18.10	83.7	10829	15.60	0.3	7334	13.93	0.0
Z830-11H50	8023	16.50	85.1	13284	14.48	5.6	8321	12.10	0.0
R709-1H50	9039	17.48	84.2						
CR812H50	7163	17.40	84.0				7163	12.13	0.9
CR813H50	8613	16.65	85.4				8647	12.25	2.4
R709-9H50	8379	15.93	85.1						
S_1 pollinators from MM,VY,S^f,Aa,Rz popns									
R878H50	7906	17.30	86.5	11533	14.36	5.6	8478	13.06	1.9
8930-19H50	8103	17.35	85.9	12582	14.96	0.0	8569	13.26	0.0
8930-39H50	7617	17.08	84.9	12030	14.85	0.0	8752	12.88	0.0
8930-102H50	7884	17.83	85.0	10693	15.24	0.0	7575	12.87	0.0
R882H50	8790	16.65	85.7	10876	14.31	0.0	7334	12.58	0.0
R876-89-5H50							8663	13.51	0.0

EVALUATION OF EXPERIMENTAL HYBRIDS, SALINAS and IMPERIAL VALLEY, CA., 1998-99

(TESTS 199, 299, 2699, 3599, 5899, B399 and B899)

(cont.)

Variety	Test 5899 (Rzm) Sugar Yield	Sucrose	RJAP	Test B399 (IV-Line) Sugar Yield	Sucrose	Bolting	Test B899 (IV-Hyb) Sugar Yield	Sucrose	Bolting
	lbs	%	%	lbs	%	%	lbs	%	%
S_1 pollinators from MM,VY,S^f,Aa,Rz popns (cont.)									
8929-41H50	9948	17.13	85.0	12219	14.97	0.0	9257	13.51	0.9
8929-72H50	6260	16.88	85.4	11210	15.21	0.3	8841	13.29	0.0
8929-102H50	8914	17.38	85.5	12258	14.64	1.2	8619	12.39	0.0
8929-112H50	10463	17.55	86.3	11503	15.19	3.6	9303	13.47	1.9
8929-114H50	11174	17.88	86.6	11800	15.47	0.3	8958	14.52	0.0
8929-115H50	8811	17.48	83.8	10919	15.47	1.5	9990	12.90	0.0
8929-133H50	9376	17.23	85.7	6710	15.69	0.0	7030	13.80	0.0
8929-153H50	7712	17.33	85.7	11287	14.79	0.0	8797	13.19	0.0
8929-154H50	9209	17.58	83.6	10593	14.11	0.0	6518	11.68	0.0
8924H50	7335	16.75	86.7	10359	14.50	2.6			
Lines & S_1 pollinators from MM,S^f,Aa,R22 popns									
4035R	9144	17.55	85.8				7593	12.78	0.0
Rizor	9416	18.05	85.4	12131	15.31	3.5	8820	13.22	0.0
Y869H50	9054	16.90	85.1						
R835H50	8663	16.95	85.2				6966	12.94	0.0
R836H50	8834	16.83	85.4				6729	11.88	0.0
Y873BH50	7960	16.50	86.7				7595	12.75	0.0
R879H50	7003	15.13	86.5				7130	11.74	1.0
Y867H50	7366	16.70	85.0				8290	12.32	0.0
Y872H50	10374	16.45	84.7				7813	12.63	1.3
Y875H50	8442	16.77	86.5				7458	12.67	0.0

EVALUATION OF EXPERIMENTAL HYBRIDS, SALINAS and IMPERIAL VALLEY, CA., 1998-99

(TESTS 199, 299, 2699, 3599, 5899, B399 and B899)

(cont.)

Variety	Test 5899 (Rzm)			Test B399 (IV-Line)			Test B899 (IV-Hyb)		
	Sugar Yield	Sucrose	RJAP	Sugar Yield	Sucrose	Bolting	Sugar Yield	Sucrose	Bolting
	lbs	%	%	lbs	%	%	lbs	%	%
Lines & S_1 pollinators from MM,S^f,Aa,R22 popns (cont.)									
8926H50 (Sp)	8367	16.40	84.6						
8926H50 (Iso)	8705	16.65	83.4						
8926H50 (Sp or Iso ?)							7927	13.24	0.9
8927-29H50	8768	18.23	85.4	11030	15.28	2.3	7938	12.99	0.0
8927-30H50	8156	17.03	85.3	11372	15.35	0.8	9141	13.05	0.0
8927-33H50	9042	17.80	85.3	9280	15.26	5.6	7852	13.11	1.0
8927-37H50	8628	16.92	85.9	11137	14.46	16.8	7751	12.10	6.9
Mean	8683.4	17.16	85.4	11178.1	14.90	1.9	7705.6	12.69	0.4
LSD (.05)	1938.5	0.77	2.5	1297.9	0.87	3.5	1574.8	1.16	2.4
C.V. (%)	16.0	3.19	2.1	11.8	5.92	182.8	14.7	6.56	394.9
F value	2.7**	6.91**	1.6*	6.6**	2.95**	6.9**	3.0**	2.20**	1.5*

EVALUATION OF PAIRCROSSES (FULL SIBS) WITH RHIZOMANIA RESISTANCE FROM *BETA MARITIMA*, SALINAS & IMPERIAL VALLEY, CA., 1998-99

(TESTS 399, 1399, 4399 and B1299)

	Test 399 (NB)			Test 1399 (VY)					Test 4399 (Rzm)				Test B1299(IV)	
Variety	%Bolt	Stand Count	DM	Sugar Yield	Sucrose	RJAP	Beets/ 100'	VY Score	Sugar Yield	Sucrose	RJAP	Root Rot	Appear Score	%Liv Plants
	8/26	Mean	%	lbs	%	%	No.	Mean	lbs	%	%	%	7/8	7/8
Checks														
US H11	19.4	17.0	14.1						4718	13.27	83.7	25.4	4.5	21.9
US H11									5579	13.83	87.1	11.1		
US H11									4073	13.80	85.9	16.3		
US H11									5179	13.33	83.5	0.0	4.0	13.3
US H11													4.5	5.3
USH11													5.0	0.0
SS-NB3	19.2	16.0	27.2											
B4776R	35.2	16.3	31.9						8636	17.27	87.5	7.5	3.0	60.1
97-C37	1.9	17.0	40.7											
97-SP22-0	81.3	17.3	40.3	4491	14.70	83.2	164	6.9						
97-US22/3	96.3	15.0	26.6											
R853	15.9	16.3	54.5						5600	15.57	84.6	17.3		
Y873	26.6	16.0	33.9						8233	16.27	83.3	21.0		
Y867	45.4	17.0	47.0	8884	16.63	84.7	145	5.0	7301	16.33	94.6	17.5		
Y867													1.0	73.1
Y872	25.4	15.7	42.8						8928	16.27	84.0	0.0		
Y872													1.5	67.6
R836									5972	14.63	82.2	11.1		
R879									5526	15.20	85.1	30.4		
R840									7823	16.20	83.2	3.6		
Rifle													3.5	41.1
SS-778R													3.0	37.9
R522 (Sp)													1.0	68.8
R522 (Sp)													1.0	82.4
8926 (Iso)													3.5	25.0
8927													2.5	31.8
Y875 (Iso)													3.0	30.2
Y875 (Iso)													3.0	28.9

EVALUATION OF PAIRCROSSES (FULL SIBS) WITH RHIZOMANIA RESISTANCE FROM *BETA MARITIMA*, SALINAS & IMPERIAL VALLEY, CA., 1998-99

(TESTS 399, 1399, 4399 and B1299)

(cont.)

	Test 399 (NB)			Test 1399 (VY)					Test 4399 (Rzm)				Test B1299(IV)	
Variety	%Bolt	Stand Count	DM	Sugar Yield	Sucrose	RJAP	Beets/ 100'	VY Score	Sugar Yield	Sucrose	RJAP	Root Rot	Appear Score	%Liv Plants
	8/26	Mean	%	lbs	%	%	No.	Mean	lbs	%	%	%	7/8	7/8
R846-# = RZM R746PX = C37*3 X R22														
R846 - 1	9.8	16.3	33.1	6369	13.90	82.2	155	6.0	6858	14.20	82.2	7.5	4.0	52.7
- 2	12.4	16.3	41.2	6182	15.00	83.5	139	5.8					3.5	38.1
- 3	15.5	15.7	53.8						7918	15.30	84.4	5.3	3.5	40.9
- 4	35.1	15.3	38.7										4.5	13.6
- 5	17.1	14.0	67.5										2.0	47.0
- 6									7186	15.33	86.2	2.6	2.0	61.8
- 7									6677	14.80	81.9	1.9	3.5	19.6
- 8									7432	15.17	84.4	2.2	3.5	31.5
R853-# = RZM R753PX = C37*4 x R22														
R853 - 1	15.4	16.0	62.5	6790	15.50	86.1	155	5.7	6693	14.60	86.4	21.5	4.5	8.3
- 2	16.7	16.3	64.6	6754	15.43	86.1	124	4.9	6422	15.03	85.1	13.0	3.5	31.3
- 3	12.5	16.3	71.2	7286	15.90	84.7	118	5.3	6637	15.07	84.8	9.1	3.0	38.0
- 4	23.9	16.7	70.5	6667	16.37	82.5	136	5.7	6408	15.83	85.6	21.3	4.0	14.3
- 5	17.1	16.0	64.7	8796	15.43	86.2	121	5.6	5760	13.80	82.8	9.2	3.5	36.7
- 6	20.8	15.3	70.8	8345	15.60	83.0	148	5.4	6706	15.10	83.0	2.4	3.0	40.6
- 7	0.0	17.0	72.3	7057	15.40	85.7	155	5.4	7899	15.03	85.4	9.2	4.0	15.9
- 8	0.0	15.7	54.6						5361	15.30	82.9	37.5	4.5	14.3
- 9	10.3	16.0	28.2						7458	15.30	84.1	10.9	3.5	50.8
-10	15.5	13.3	38.5						7023	14.50	86.3	5.6	4.0	15.1
-11	5.1	14.0	27.2						7104	15.33	84.2	1.8	3.5	30.0
-12	8.9	14.7	49.7						6498	15.33	88.8	28.1	4.0	12.4
-13	40.0	14.7	51.3						6543	14.83	84.3	20.7	3.5	41.3
-14	27.6	14.3	32.9						9057	15.63	84.5	10.4	4.5	28.6
-15	7.2	14.3	12.0										4.5	6.3

EVALUATION OF PAIRCROSSES (FULL SIBS) WITH RHIZOMANIA RESISTANCE FROM *BETA MARITIMA*,
SALINAS & IMPERIAL VALLEY, CA., 1998-99

(TESTS 399, 1399, 4399 and B1299)

(cont.)

	Test 399 (NB)			Test 1399 (VY)					Test 4399 (Rzm)				Test B1299(IV)	
Variety	%Bolt	Stand Count	DM	Sugar Yield	Sucrose	RJAP	Beets/ 100'	VY Score	Sugar Yield	Sucrose	RJAP	Root Rot	Appear Score	%Liv Plants
	8/26	Mean	%	lbs	%	%	No.	Mean	lbs	%	%	%	7/8	7/8
R853-# = RZM R753PX = C37*4 x R22 (cont.)														
R853 -16	35.8	15.7	47.0										4.0	26.2
-17	13.7	17.0	27.5										4.0	28.2
-18									7002	14.47	84.3	21.4	3.5	53.3
-19									7294	15.57	86.8	2.1	3.5	31.4
-20													3.5	29.0
-21													3.5	45.7
-22													4.5	14.3
Y873-# = RZM Y773 PX = F_2 (C37 x Y71)														
Y873 - 1	17.0	16.0	39.4	6100	15.40	84.3	136	5.1	5761	15.50	86.2	15.7	5.0	0.0
- 2	64.6	16.0	27.1	8828	15.97	82.5	109	5.7	6623	15.93	81.7	21.1	3.5	34.1
- 3	37.0	14.3	31.3	5600	14.67	82.4	124	5.8	6547	15.57	82.5	12.4	3.0	43.3
- 4	55.1	15.7	12.8	7230	15.17	84.1	127	5.1	7824	15.67	85.6	2.0	4.0	26.9
- 5	33.1	15.3	54.3	5380	15.30	78.7	142	5.6	4660	16.17	79.9	0.0	2.0	53.5
- 6	59.6	15.7	23.5	7225	14.97	83.6	133	5.8	7625	15.37	84.0	14.5	4.0	23.3
- 7	59.0	16.3	38.8	6430	15.83	82.9	152	5.5	6320	15.93	84.6	1.8	4.0	34.2
- 8	41.4	15.3	17.5	6965	15.20	84.8	142	5.3	7746	15.70	87.2	2.2	4.5	7.5
- 9	24.6	16.3	24.5	7565	16.33	84.2	145	5.8	7310	15.47	83.3	12.5	1.5	53.9
-10	46.3	14.3	25.6	6757	15.47	82.4	139	6.1	7197	15.70	84.1	2.6	3.5	28.8
-11	54.3	15.3	25.8	6367	15.10	80.9	133	5.8	7583	15.53	81.7	9.6	4.0	23.5
-12	59.3	15.3	24.2	5732	14.77	82.1	145	6.1	5008	14.17	85.8	13.1	4.5	7.1
-13	59.6	15.7	18.2						7896	15.70	83.7	1.6	3.0	49.4
-14	53.3	15.0	28.9						6484	15.43	83.3	14.3	2.5	40.8
-15	37.0	12.7	15.8						7747	16.37	84.4	8.9	2.5	27.8

EVALUATION OF PAIRCROSSES (FULL SIBS) WITH RHIZOMANIA RESISTANCE FROM *BETA MARITIMA*, SALINAS & IMPERIAL VALLEY, CA., 1998-99

(TESTS 399, 1399, 4399 and B1299)

(cont.)

Variety	Test 399 (NB) %Bolt 8/26	Test 399 (NB) Stand Count Mean	Test 399 (NB) DM %	Test 1399 (VY) Sugar Yield lbs	Test 1399 (VY) Sucrose %	Test 1399 (VY) RJAP %	Test 1399 (VY) Beets/ 100' No.	Test 1399 (VY) VY Score Mean	Test 4399 (Rzm) Sugar Yield lbs	Test 4399 (Rzm) Sucrose %	Test 4399 (Rzm) RJAP %	Test 4399 (Rzm) Root Rot %	Test B1299(IV) Appear Score 7/8	Test B1299(IV) %Liv Plants 7/8
Y873-# = RZM Y773 PX = F_2 (C37 x Y71) (cont.)														
Y873 -16	41.2	9.3	35.7										3.0	36.1
-17	83.3	0.7	100.0										4.0	50.0
-18	72.1	14.3	58.7										3.0	56.0
-19									8280	15.80	82.4	7.5	4.0	13.8
-20													3.5	24.4
Y872 -10									8963	16.13	81.4	4.2		
Y867-# = RZM Y767 PX = Y31 x (O.P. x R22)														
Y867 - 1	84.3	15.0	21.4	8938	16.27	84.5	124	5.2	1145	16.33	83.2	2.2	1.5	61.3
- 2	71.2	15.0	36.9	7836	16.37	82.1	136	5.1	8723	16.93	85.6	14.5	1.0	63.5
- 3	65.2	15.3	45.5	7870	16.80	84.9	145	5.4	9356	16.50	85.7	23.4	1.0	64.9
- 4	54.3	15.0	59.1	8835	16.23	84.7	155	5.8	8442	15.77	86.0	4.2	3.5	31.8
- 5	57.1	14.7	34.3	10580	16.77	86.0	148	5.2	8482	15.50	85.2	6.3	4.0	21.9
- 6	61.7	15.7	30.0	8620	17.83	85.1	133	4.5	7936	16.20	84.9	2.4	2.5	65.0
- 7	83.3	15.0	57.4	9579	16.93	85.2	130	4.7	9379	16.70	86.7	14.2	2.0	53.8
- 8	95.8	15.0	33.8	8625	16.90	85.8	136	4.9	6340	14.27	87.1	30.3	2.5	60.7
- 9	89.2	15.7	37.9	10371	17.00	86.2	121	4.5	8443	15.97	86.5	9.3	2.0	66.2
-10	84.5	14.7	31.8						5519	14.53	84.4	21.8	3.5	37.1
-11	74.9	15.7	31.8						8335	16.87	85.4	4.4	3.0	53.9
Y871-# = RZM Y771 PX = O.P. x R22														
Y871 - 1	7.5	17.0	31.3	9050	16.17	83.2	158	5.8	8713	15.83	84.2	11.0	1.5	67.4
- 2	36.3	16.3	33.5	7388	15.43	83.9	158	5.8	7909	15.67	84.6	4.6	4.0	25.0
- 3	56.3	16.0	50.0	9195	16.43	85.5	148	5.3	9436	15.83	84.8	8.5	3.5	43.3
- 4	14.8	16.0	57.9	9777	16.00	84.0	136	5.8	8090	15.73	82.9	4.2	1.5	50.4
- 5	35.8	14.3	51.7	7252	17.57	81.7	155	4.8	5499	14.40	85.0	8.6	2.0	55.6

EVALUATION OF PAIRCROSSES (FULL SIBS) WITH RHIZOMANIA RESISTANCE FROM *BETA MARITIMA*, SALINAS & IMPERIAL VALLEY, CA., 1998-99

(TESTS 399, 1399, 4399 and B1299)

(cont.)

	Test 399 (NB)			Test 1399 (VY)					Test 4399 (Rzm)				Test B1299(IV)	
Variety	%Bolt 8/26	Stand Count Mean	DM %	Sugar Yield lbs	Sucrose %	RJAP %	Beets/ 100' No.	VY Score Mean	Sugar Yield lbs	Sucrose %	RJAP %	Root Rot %	Appear Score 7/8	%Liv Plants 7/8
Y871-# = RZM Y771 PX = O.P. x R22 (cont.)														
Y871 - 6	43.5	15.3	55.3	9432	16.40	85.0	136	5.8	9176	15.93	85.5	9.4	1.5	68.5
- 7	89.2	14.7	36.6	7879	15.77	83.0	133	5.3	7538	14.77	84.7	5.6	3.0	28.3
- 8	57.8	15.0	15.6	5679	16.17	83.1	115	6.2	5905	14.33	79.5	37.5	4.0	17.0
- 9	42.5	12.0	26.2						7209	16.10	83.8	5.6	2.5	45.7
-10	66.1	14.0	64.4						7282	14.23	82.9	20.0	3.5	30.8
-11													2.0	60.5
Y872-# = RZM Y772 PX = R80,R76 x (C37 x R22)														
Y872 - 1	70.7	15.0	34.6	9250	16.27	85.2	118	4.8	7227	15.77	84.9	11.1	2.0	34.0
- 2	34.9	17.0	56.1	7118	15.53	84.3	118	5.8	7830	15.13	81.0	0.0	1.5	63.9
- 3	26.1	15.3	15.1	10456	15.57	85.4	124	4.7	8565	14.70	85.5	7.8	3.0	37.5
- 4	6.3	15.7	36.5	6441	16.87	83.0	115	6.3	8601	16.90	82.5	0.0	1.5	64.7
- 5	32.2	15.7	29.7	8589	16.87	87.1	124	4.8	7268	16.43	88.6	20.7	4.5	16.7
- 6	0.0	13.3	55.3	6291	15.87	81.9	130	5.7	7400	16.03	82.1	2.1	1.5	71.9
- 7	18.7	16.0	54.4	7799	15.57	82.2	118	6.2	9594	16.03	83.4	10.9	2.5	41.7
- 8	43.3	14.7	35.7	8613	15.97	85.4	115	5.0	8266	16.23	86.8	17.3	2.0	49.1
- 9	29.5	15.0	32.7						8858	16.30	82.2	9.5	1.0	74.8
-10													2.0	74.6
8934-# = R776-89-5NB x RZM 7934-# (C913-70aa x R636)														
8934 - 1													3.5	40.8
- 2													2.5	42.1
- 3													3.0	29.3
- 4													4.5	5.6
- 5													1.5	74.4
- 6													2.5	47.2

EVALUATION OF PAIRCROSSES (FULL SIBS) WITH RHIZOMANIA RESISTANCE FROM *BETA MARITIMA*,
SALINAS & IMPERIAL VALLEY, CA., 1998-99

(TESTS 399, 1399, 4399 and B1299)

(cont.)

	Test 399 (NB)			Test 1399 (VY)					Test 4399 (Rzm)				Test B1299(IV)	
Variety	%Bolt	Stand Count	DM	Sugar Yield	Sucrose	RJAP	Beets/ 100'	VY Score	Sugar Yield	Sucrose	RJAP	Root Rot	Appear Score	%Liv Plants
	8/26	Mean	%	lbs	%	%	No.	Mean	lbs	%	%	%	7/8	7/8
8926-# = RZM 7926⊗ = MM,S^f,Aa,R22 (gh 4)														
8926 - 1													2.5	72.9
- 2													3.0	43.3
- 3													4.0	18.4
- 4													3.0	60.0
- 5													5.0	0.0
- 6													5.0	0.0
- 7													4.0	11.3
- 8													5.0	0.0
- 9													5.0	0.0
-10													4.5	5.9
-11													4.0	14.6
-12													4.0	22.5
-13													3.5	41.2
-14													5.0	0.0
-15													5.0	0.0
-16													2.5	62.9
P807B-# = R778% x RZM P707B ((Y71 x P603)(~CP01)) (gh 10)														
P807B - 2													1.0	74.1
- 4													2.5	61.6
- 5													2.5	55.6
- 8													1.5	66.6
P808B-# = R778% x RZM P708B ((Y71 x P604)(~CP02)) (gh 10)														
P808B - 2													2.5	63.1
- 3													4.0	5.4
- 4													3.5	30.5
- 7													1.5	56.9

EVALUATION OF PAIRCROSSES (FULL SIBS) WITH RHIZOMANIA RESISTANCE FROM *BETA MARITIMA*, SALINAS & IMPERIAL VALLEY, CA., 1998-99

(TESTS 399, 1399, 4399 and B1299)

	Test 399 (NB)			Test 1399 (VY)					Test 4399 (Rzm)				Test B1299(IV)	
Variety	%Bolt 8/26	Stand Count Mean	DM %	Sugar Yield lbs	Sucrose %	RJAP %	Beets/ 100' No.	VY Score Mean	Sugar Yield lbs	Sucrose %	RJAP %	Root Rot %	Appear Score 7/8	%Liv Plants 7/8
Mean	39.5	15.2	40.4	7692.9	15.91	83.9	135.9	5.5	7319.3	15.45	84.4	10.9	3.2	37.1
LSD (.05)	22.0	1.9	34.2	1626.6	0.73	3.0	33.1	0.6	1991.8	1.01	3.7	20.5	1.4	32.8
C.V. (%)	34.6	7.9	52.5	13.0	2.83	2.2	15.0	6.8	16.9	4.06	2.7	116.6	22.8	44.7
F value	11.1**	8.8**	1.9**	6.2**	9.23**	2.5**	1.4NS	5.8**	3.4**	5.43**	1.9**	1.5*	4.7**	3.5**

TEST 399 NOTES: See Tests 1399 and 4399 for performance under virus yellows and rhizomania. Tests 199 thru 999 were infected with *Sclerotium rolfsii*, southern root rot. After each counting for bolting, seed stalks were trimmed to canopy level. Due to root rot, high levels of bolting, and trimming, the second and third counts were more difficult to make. In general, it appears that counts for bolting made 8/26/99 are best indication of relative bolting tendency. Level of bolting in 1999 tests was very high due to a long vernalization period in the winter and spring.

Emergence scored on a scale of 0 to 5 where 0 = no emerged plants. Downy mildew infected plants counted 5/26/99. Downy mildew infection became moderately severe and probably affected bolting tendency and late summer survival.

TEST 1399 NOTES: See tests 399 and 4399for companion tests under bolting and rhizomania conditions. Inoculated with VY (BYV-BWYV-BChV).

TEST 4399 NOTES: Harvested by machine with 10% tare used. Root rot due to *Sclerotium rolfsii*. Rotted roots counted before harvest. Rotted roots weighed but not included in sugar sample. Weights adjusted for missing feet, but not for root rot. Also see results from bolting, virus yellows, and Brawley trials.

TEST B1299 NOTES:
Appearance scored on a scale of 1 to 5 where: 1 = very good canopy; 2 = good canopy and appearance often segregating; 3 = intermediate and variable; 4 = fair; and 5 = poor to mostly dead plants. Appearance scored relative to the overall test at time and based upon canopy size, uniformity, color, vigor, number of dead leaves, and dead plants. The assumption was that plant health and appearance was mostly being influenced by reaction to rhizomania and rhizomania under high temperature conditions. However, other factors such as plant vigor, cyst nematode infection, root rots, etc. could have influenced appearance.

Coefficients of correlation for % Living plants vs. Appearance scores for 5/12,6/11, & 7/8 and Stand Counts (October 1998) are r = -.60**, -.72**, -.87**, and 0.01, respectively. Stand counts made post thinning in October. Living plants counted 08 July 1999.

EVALUATION OF PAIRCROSSES (FULL SIBS) WITH C31*Rz* GERMPLASM, SALINAS, CA., 1999

(TESTS 499, 1499 and 4499)

	Test 499 (NB)			Test 1499 (VY)					Test 4499 (Rzm)			
Variety	%Bolt 8/26	Stand Count Mean	DM %	Sugar Yield lbs	Sucrose %	RJAP %	Beets/ 100' No.	VY Score Mean	Sugar Yield lbs	Sucrose %	RJAP %	Root Rot %
Checks												
Y869 (Iso)	58.1	16.7	26.3	8799	16.07	83.7	136	3.8	7054	16.27	86.1	19.7
R876-89-5NB	21.4	17.3	5.8	9425	16.47	85.2	155	4.4	6577	16.80	83.7	1.9
97-C37	3.9	16.7	34.3	7225	15.77	83.5	161	4.4				
97-SP22-O	82.8	15.3	25.6	3149	13.10	81.1	133	6.4				
US H11									5223	13.40	84.7	19.7
B4776R									10547	17.10	86.7	5.3
Y868-# = RZM Y768 PX												
Y868 - 1	0.0	16.0	51.7	8282	17.30	85.8	152	4.8	6934	17.20	86.2	11.7
- 2	20.7	15.7	39.0	11354	17.00	85.5	145	3.8	7513	16.07	84.6	5.1
- 3	70.0	16.0	34.3	9423	16.83	83.6	148	4.4	7369	16.07	83.4	4.5
- 4	31.6	16.3	40.8	7831	16.93	85.4	136	3.8	8258	17.43	84.6	14.8
- 5	6.7	15.3	56.7	7220	14.60	85.5	127	4.2	6827	15.07	84.9	21.5
- 6	39.3	15.3	15.1	9753	16.83	82.5	148	3.3	7997	16.87	86.6	17.1
- 7	19.9	16.7	43.9	9916	16.47	86.7	139	4.3	7032	15.07	85.4	5.6
- 8	19.1	16.0	57.9	7429	15.07	85.3	139	4.6	7120	15.53	86.5	9.4
- 9	74.1	14.3	37.1						7238	15.60	83.9	2.4
-10	9.3	14.0	50.5						6537	16.00	83.6	2.4
-11	55.9	13.3	57.3						7540	15.83	89.5	55.2
-12	7.5	13.3	54.8						6347	15.63	87.3	5.2
-13	23.1	15.7	32.1						7788	16.07	88.2	12.5
-14	9.3	15.0	77.2						6047	16.17	84.8	8.3

EVALUATION OF PAIRCROSSES (FULL SIBS) WITH C31*Rz* GERMPLASM, SALINAS, CA., 1999

(TESTS 499, 1499 and 4499)

(cont.)

	Test 499 (NB)			Test 1499 (VY)					Test 4499 (Rzm)			
Variety	%Bolt 8/26	Stand Count Mean	DM %	Sugar Yield lbs	Sucrose %	RJAP %	Beets/ 100' No.	VY Score Mean	Sugar Yield lbs	Sucrose %	RJAP %	Root Rot %
Y869-# = RZM Y769 PX												
Y869 - 1	70.2	16.7	59.2	9892	16.73	83.8	127	3.7	9153	16.57	83.4	4.4
- 2	16.4	16.7	32.4	8500	16.87	84.6	133	4.4	7042	16.83	83.2	4.9
- 3	53.2	16.3	43.1	9653	15.80	84.3	139	5.1	8540	16.43	85.0	16.6
- 4	51.5	17.0	39.4	9926	15.33	84.1	136	3.8	7905	15.53	86.0	12.0
- 5	74.7	15.7	42.6	11830	16.13	84.3	145	3.6	7424	16.37	87.7	0.0
- 6	56.9	16.3	32.5	8421	15.77	82.6	124	4.8	7222	16.47	85.7	7.7
- 7	32.5	17.0	5.5	8846	16.50	82.4	148	4.1	8550	17.67	84.1	14.1
- 8	46.8	17.0	37.6	10088	15.27	85.0	145	4.0	7473	15.93	84.3	2.0
- 9	33.2	16.3	29.7	10894	16.07	85.7	139	3.8	7569	16.50	85.2	15.0
-10	10.2	16.7	85.9	9931	16.53	83.8	148	3.7	7818	16.17	84.8	4.3
-11	3.6	18.0	30.8	10954	15.93	84.2	158	4.8	7495	16.50	86.7	2.4
-12	49.5	17.0	29.1	9177	15.63	83.3	136	4.3	7090	15.47	84.1	5.8
-13	34.5	16.3	61.1	10982	17.00	83.1	139	4.2	8468	17.50	83.7	6.3
-14	63.6	15.3	63.3	8116	15.87	83.5	124	4.3	6569	15.20	86.5	32.9
-15	7.1	16.0	48.5	8952	16.00	83.9	136	4.4	7297	15.87	85.4	11.9
-16	48.0	15.0	47.1	9569	16.37	84.9	112	4.1	8372	16.00	85.7	4.1
-17	72.7	14.7	40.2	9357	16.10	87.6	124	3.3	6105	15.53	86.1	19.8
-18	49.1	16.3	58.8	10415	16.83	86.0	121	4.3	8838	16.97	86.3	1.9
-19	70.5	16.7	63.7	8968	16.17	84.9	115	3.8	7066	16.30	83.7	12.0
-20	50.6	15.0	37.1	7952	15.03	83.8	118	4.7	5848	15.70	85.8	20.8
-21	51.0	15.0	69.7	8648	16.53	83.3	130	4.0	8760	17.27	84.9	19.6
-22	38.3	13.7	21.0	9336	15.40	86.0	109	4.9	8196	15.93	85.1	31.3
-23	56.3	15.7	16.7	10863	16.93	83.7	133	4.5	7843	16.37	83.7	3.6
-24	50.4	14.0	55.8	8883	15.80	86.0	130	4.0	6585	15.30	85.6	11.9

EVALUATION OF PAIRCROSSES (FULL SIBS) WITH C31*Rz* GERMPLASM, SALINAS, CA., 1999

(TESTS 499, 1499 and 4499)

(cont.)

	Test 499 (NB)			Test 1499 (VY)					Test 4499 (Rzm)			
Variety	%Bolt 8/26	Stand Count Mean	DM %	Sugar Yield lbs	Sucrose %	RJAP %	Beets/ 100' No.	VY Score Mean	Sugar Yield lbs	Sucrose %	RJAP %	Root Rot %
Y869-# = RZM Y769 PX (cont.)												
Y869 -25	32.8	15.3	12.9	11479	16.47	84.6	142	4.6	8337	16.00	85.9	4.4
-26	26.9	15.0	15.8	10764	16.93	82.5	152	3.9	7672	16.93	85.8	2.0
-27	62.8	13.7	33.5						7913	16.90	86.2	7.0
-28	55.0	12.0	66.8						8071	17.03	84.2	23.1
R886-89-5NB- 1	27.0	15.3	4.5	7835	15.53	84.0	155	4.3	5914	16.33	82.1	2.2
- 2	10.1	16.3	6.1	7530	16.43	81.0	161	4.6	7221	17.47	82.7	3.2
- 3	24.1	16.3	5.9	8165	15.57	81.1	155	4.2	7542	17.00	83.5	1.9
- 4	29.2	16.0	14.6	7820	16.17	82.5	158	4.1	7961	17.37	84.0	0.0
- 5	20.4	16.0	14.3	7899	16.27	81.3	118	4.3	5608	15.90	79.1	0.0
- 6	43.3	15.3	25.8	9564	16.40	83.4	139	4.3	7675	17.33	83.1	5.1
- 7	61.5	16.3	20.5	7319	15.80	82.3	152	4.3	7688	16.97	84.4	5.3
- 8	37.2	15.3	6.5	7866	16.60	82.6	148	4.7	7212	17.33	83.9	0.0
- 9	28.6	15.7	0.0	8418	16.57	84.5	152	3.9	7048	17.90	84.0	0.0
-10	7.3	14.0	0.0	7062	16.33	81.3	155	4.8	5480	17.63	84.1	2.2
-11	72.2	14.0	2.6	8767	15.63	83.3	155	3.8	7113	16.83	83.2	0.0
-12	35.5	15.0	8.6	7825	16.20	83.1	148	4.2	5256	16.93	79.6	2.2
-13	35.5	15.7	18.6	7317	15.63	80.9	155	4.4	6097	16.37	81.8	2.2
-14	25.4	16.0	10.4	7825	16.17	83.6	152	4.2	6857	16.87	83.6	2.1
-15	71.9	15.7	0.0	10700	15.83	83.0	152	5.0	7793	16.97	81.7	3.7
-16	31.6	14.7	0.0	7575	16.17	82.6	142	4.2	7511	17.33	85.0	0.0
-17	67.5	14.7	9.0	8188	16.27	82.0	121	4.8	7859	17.13	85.1	0.0

EVALUATION OF PAIRCROSSES (FULL SIBS) WITH C31*Rz* GERMPLASM, SALINAS, CA., 1999

(TESTS 499, 1499 and 4499)

(cont.)

	Test 499 (NB)			Test 1499 (VY)					Test 4499 (Rzm)			
Variety	%Bolt	Stand Count	DM	Sugar Yield	Sucrose	RJAP	Beets/ 100'	VY Score	Sugar Yield	Sucrose	RJAP	Root Rot
	8/26	Mean	%	lbs	%	%	No.	Mean	lbs	%	%	%
R876-# = RZM R776 PX												
R876 - 1	32.3	15.7	15.0	9404	15.80	83.8	136	4.8	7750	16.20	84.8	0.0
- 2	33.1	15.3	30.0	7022	14.80	84.3	130	5.2	7136	15.57	85.4	2.1
- 3	0.0	16.0	57.7	7803	15.23	84.0	127	5.0	7475	15.60	86.3	10.1
- 4	13.1	16.0	30.5	8058	14.67	83.8	142	5.2	7328	15.60	84.6	9.2
- 5	2.1	16.0	41.7	7845	15.10	84.2	124	4.4	8515	16.30	85.6	4.8
- 6	29.9	16.3	16.7	8796	16.30	84.9	145	4.3	8102	16.20	84.6	6.7
- 7	4.2	16.0	43.8	8625	15.40	82.7	145	5.0	7818	15.33	83.3	1.9
- 8	10.3	16.3	14.2	7244	15.13	85.0	133	5.6	5964	15.20	84.2	7.4
- 9	0.0	16.0	41.7	8193	15.67	83.9	152	5.3	6492	14.63	84.2	2.2
-10	4.0	16.3	69.2	10623	15.93	85.4	136	4.2	7769	15.73	84.4	3.7
-11	22.5	16.3	53.1	7286	15.10	83.6	124	4.7	7266	15.47	84.2	0.0
-12	45.8	15.3	17.2	8739	16.03	85.3	124	4.8	7523	16.23	86.2	0.0
R881-43-# = RZM R781-43 PX												
R881-43 - 1	5.9	16.3	41.5	7446	15.07	82.5	145	5.8	6513	15.37	85.0	5.6
- 2	26.8	16.0	59.2	9139	16.37	86.0	136	4.4	8500	16.53	85.7	2.1
- 3	0.0	15.3	45.0	7481	15.30	84.6	133	5.5	6919	15.80	87.5	9.9
- 4	28.6	15.7	34.1	7974	15.67	82.7	145	5.2	7535	16.07	84.0	2.0
- 5	47.3	14.3	56.5	10652	15.27	85.3	118	4.4	8859	16.07	87.3	1.9
- 6	28.1	16.3	92.4	8545	14.97	84.9	152	4.7	6760	15.67	86.4	5.6
- 7	22.5	17.0	90.0	7314	15.30	82.4	145	4.9	6618	16.43	86.0	2.1
- 8	62.7	17.0	60.8	7927	15.60	82.7	145	5.0	7687	15.90	83.4	2.6
- 9	48.3	17.3	73.0	8745	15.47	82.4	133	5.0	7518	16.77	83.4	0.0
-10	14.7	16.7	27.3	8622	16.00	83.8	133	4.7	7929	16.60	84.2	0.0

EVALUATION OF PAIRCROSSES (FULL SIBS) WITH C31*Rz* GERMPLASM, SALINAS, CA., 1999

(TESTS 499, 1499 and 4499)

(cont.)

	Test 499 (NB)			Test 1499 (VY)					Test 4499 (Rzm)			
Variety	%Bolt 8/26	Stand Count Mean	DM %	Sugar Yield lbs	Sucrose %	RJAP %	Beets/ 100' No.	VY Score Mean	Sugar Yield lbs	Sucrose %	RJAP %	Root Rot %
R881-# = RZM R781 PX												
R881 - 1	58.8	15.3	26.1	10183	14.63	83.0	148	4.0	7095	14.97	85.3	6.3
- 2	71.8	14.3	46.5	10402	15.47	83.4	148	4.5	7966	15.60	84.9	2.1
- 3	66.8	16.0	51.6	10827	14.37	85.2	158	4.2	9790	15.10	85.8	2.0
- 4	61.4	17.3	57.7	11115	16.17	85.7	142	4.7	7604	16.40	87.9	15.7
- 5	48.8	15.0	53.0	8611	15.27	84.6	148	5.3	8042	15.50	84.9	4.2
- 6	48.4	16.3	34.9	10186	15.07	84.5	142	4.1	8509	15.63	85.9	0.0
- 7	65.5	15.0	47.9	8439	14.67	82.7	158	5.2	9042	15.30	87.2	2.1
- 8	64.0	16.7	46.8	8604	15.37	83.4	161	5.3	8304	14.80	83.7	16.4
- 9	52.1	16.0	50.0	9002	15.60	84.5	152	5.1	8918	16.13	87.1	7.4
-10	65.5	15.3	21.7	11175	15.70	83.5	148	4.4	9454	15.73	84.9	9.8
-11	42.9	16.3	63.2	9704	14.80	84.3	136	4.3	9117	15.33	84.7	5.9
-12	41.8	16.0	35.7	8884	14.93	84.4	139	4.8	9184	14.33	85.8	9.4
-13	56.5	15.3	60.6	9552	15.13	84.1	124	4.1	9675	15.20	84.9	3.7
-14	67.4	16.7	42.5	9427	16.10	85.3	133	5.0	8389	15.67	85.5	10.6
-15	29.6	15.7	47.9	8664	15.23	84.7	139	4.5	8439	15.53	84.7	2.4
-16	70.6	17.0	19.6	9018	15.27	84.7	124	4.6	8318	15.90	86.4	7.5
-17	61.2	16.3	32.6	7324	15.47	81.8	133	4.8	9400	16.03	85.0	3.9
-18	42.6	15.7	74.3	10383	13.43	85.0	133	4.8	9829	15.00	85.7	11.8
-19	53.6	15.3	40.7	8706	15.00	85.1	124	4.7	8228	15.73	85.3	10.8
-20	38.9	16.0	49.2	11893	15.47	85.8	124	3.5	8239	15.17	84.0	8.9
-21	35.2	13.7	71.3	7189	14.87	83.5	106	4.8	6889	15.03	85.3	9.8

EVALUATION OF PAIRCROSSES (FULL SIBS) WITH C31*Rz* GERMPLASM, SALINAS, CA., 1999

(TESTS 499, 1499 and 4499)

(cont.)

	Test 499 (NB)			Test 1499 (VY)					Test 4499 (Rzm)			
Variety	%Bolt	Stand Count	DM	Sugar Yield	Sucrose	RJAP	Beets/ 100'	VY Score	Sugar Yield	Sucrose	RJAP	Root Rot
	8/26	Mean	%	lbs	%	%	No.	Mean	lbs	%	%	%
R870-# = RZM R770 PX												
R870 - 1	4.4	15.3	61.7	7686	16.07	85.2	139	4.0	6246	16.00	86.0	33.8
- 2	37.5	16.0	33.3	9047	16.03	82.7	136	4.8	9083	17.10	84.5	23.5
- 3	52.1	16.7	13.9	10426	16.80	83.0	145	4.6	8787	16.97	83.9	29.8
- 4	64.0	15.7	57.6	10974	15.97	84.0	142	4.4	9198	15.83	83.4	13.7
- 5	0.0	16.7	37.9	8465	16.33	82.7	145	4.7	5154	15.27	83.3	24.3
- 6	29.6	17.0	39.6	8257	16.03	84.7	142	5.1	6450	15.50	82.7	53.0
R870-# in Bolting Test 599												
R870 - 7				7757	15.70	84.1	121	5.2				
- 8				8881	15.87	80.9	142	4.5				
- 9				8746	16.90	85.9	130	4.4				
-10				10211	16.20	82.2	139	4.0				
R870-# not included in Bolting Tests												
R870 -11				9409	15.90	83.5	145	4.2				
-12				9346	15.40	81.7	161	4.9				
-13				9962	15.53	83.1	148	4.6				
-14				9137	16.20	86.7	155	4.7				
Mean	38.1	15.8	38.4	8928.2	15.80	83.9	139.6	4.5	7610.1	16.12	84.9	8.6
LSD (.05)	22.5	1.9	30.6	1951.2	0.8	2.9	28.0	0.6	1915.3	0.91	2.9	16.6
C.V. (%)	36.8	7.6	49.6	13.6	3.17	2.1	12.5	7.9	15.6	3.51	2.2	120.1
F value	7.7**	2.1**	3.8**	3.7**	6.29**	1.8**	1.5**	6.5**	2.4**	6.02**	2.2**	2.7**

EVALUATION OF PAIRCROSSES (FULL SIBS) OF C78 & C80, SALINAS, CA., 1999

(TESTS 599, 1599, 4599)

Variety	Test 599 (NB) %Bolt 8/26	Test 599 (NB) Stand Count Mean	Test 599 (NB) DM %	Test 1599 (VY) Sugar Yield lbs	Test 1599 (VY) Sucrose %	Test 1599 (VY) RJAP %	Test 1599 (VY) Beets/ 100' No.	Test 1599 (VY) VY Score Mean	Test 4599 (Rzm) Sugar Yield lbs	Test 4599 (Rzm) Sucrose %	Test 4599 (Rzm) RJAP %	Test 4599 (Rzm) RZM Resist %	Test 4599 (Rzm) Root Rot %
Checks													
R878%	32.1	17.3	33.4	8593	16.43	84.9	167	5.0	8131	16.53	84.1	90.3	6.7
R880	30.4	16.3	49.4	7633	16.27	84.0	139	5.5	7922	16.70	83.4	93.4	10.3
97-US75				4605	14.93	81.6	152	5.5					
97-SP22-O				3087	15.17	82.3	167	6.0					
R881				9251	16.10	84.6	148	5.0					
R876-89-5NB				7795	16.47	82.3	167	4.6					
Y869(Iso)				8573	15.70	82.9	152	4.6					
R878-# = RZM R778 PX													
R878 - 1	95.4	16.0	37.7	9206	16.20	86.9	145	4.8	8807	16.63	85.0	85.2	8.8
- 2	58.5	16.0	58.5	9108	16.73	82.8	148	4.8	7825	17.03	83.1	87.9	7.1
- 3	4.2	15.0	50.8	7668	16.73	85.7	158	5.3	8147	16.97	85.9	96.1	3.9
- 4	3.9	17.3	44.6	9476	16.57	85.8	155	5.0	8782	16.77	86.3	83.9	15.7
- 5	18.0	16.7	15.9	6502	16.40	81.9	145	3.9	7774	16.80	83.0	85.9	7.8
- 6	62.5	16.0	77.1	8347	16.57	84.7	136	4.8	8126	16.77	84.4	86.7	4.0
- 7	37.5	16.0	77.1	8439	15.83	84.7	130	4.8	8922	16.03	83.4	87.5	11.7
- 8	2.0	17.0	45.1	7817	16.00	82.0	139	4.9	8031	16.90	82.0	91.7	17.5
- 9	4.2	16.3	66.9	7255	17.00	82.9	136	5.0	8817	17.63	84.6	95.4	11.5
-10	12.4	16.0	84.1	7662	15.93	82.6	145	4.6	7742	16.70	83.4	84.6	0.0
-11	53.8	16.0	55.7	8858	16.30	84.3	145	4.8	8527	16.97	84.9	78.8	26.4
-12	30.9	14.3	68.9	8849	16.57	83.7	152	5.6	8215	17.13	83.3	96.1	16.7
R880-# = RZM R780 PX													
R880 - 1	2.0	16.0	72.2	6664	16.00	82.6	139	5.7	3693	15.63	82.3	32.5	0.0
- 2	23.6	16.0	42.9	7240	15.80	83.2	145	5.2	7729	16.37	82.2	94.2	2.1

EVALUATION OF PAIRCROSSES (FULL SIBS) OF C78 & C80, SALINAS, CA., 1999

(TESTS 599, 1599, 4599)

	Test 599 (NB)			Test 1599 (VY)					Test 4599 (Rzm)				
Variety	%Bolt	Stand Count	DM	Sugar Yield	Sucrose	RJAP	Beets/ 100'	VY Score	Sugar Yield	Sucrose	RJAP	RZM Resist	Root Rot
	8/26	Mean	%	lbs	%	%	No.	Mean	lbs	%	%	%	%
R880-# = RZM R780 PX (cont.)													
R880 - 3	38.9	16.0	31.9	7816	16.70	85.6	127	5.1	8320	16.63	84.7	98.0	0.0
- 4	0.0	16.3	55.1	7714	15.77	83.2	136	4.9	5601	16.03	82.3	69.5	9.8
- 5	2.1	16.3	8.0	8514	16.40	84.2	142	5.6	8740	17.30	83.0	93.9	0.0
- 6	10.7	16.0	52.4	7819	16.33	82.6	139	5.2	6202	16.73	83.7	73.5	0.0
- 7	10.2	16.3	39.1	9167	15.90	80.9	164	4.3	7708	15.93	81.8	91.9	7.4
- 8	37.7	16.7	86.0	9618	16.47	83.0	158	4.7	8069	16.40	78.5	94.9	0.0
- 9	0.0	16.3	32.8	8408	16.53	83.6	152	5.2	8127	17.30	83.8	89.2	7.8
-10	32.4	16.7	38.0	7942	15.93	83.1	164	4.8	7108	15.93	85.1	82.2	7.8
-11	0.0	15.7	32.3	7789	15.77	83.4	139	5.5	8054	15.70	83.8	98.0	11.0
-12	40.4	15.7	27.4	8322	16.67	82.5	142	4.7	7038	16.33	83.9	78.5	27.8
-13	20.7	16.3	20.6	8543	16.80	83.4	155	5.2	7210	17.30	82.5	91.9	20.0
-14	92.0	16.3	37.1	7568	15.97	82.1	155	5.2	6572	16.37	82.1	82.5	7.2
-15	0.0	16.3	28.4	7715	15.27	84.8	148	4.8	5613	14.80	81.2	71.7	29.0
-16	69.7	16.3	19.4	8783	16.27	83.7	139	4.8	8519	16.87	84.3	97.2	15.6
-17	2.0	16.0	21.7	7208	16.20	81.8	133	4.3	7228	17.10	83.7	97.9	9.3
-18	51.8	17.3	34.8	9278	15.97	84.0	139	5.2	7645	16.83	83.2	92.7	12.2
-19	76.5	15.7	37.9	7118	15.37	83.5	124	5.0	8380	16.53	82.1	88.7	0.0
-20	68.6	15.3	12.3	8552	15.13	82.0	124	4.3	7781	16.50	83.6	87.1	16.9
R880/2-# = RZM R780/2 PX													
R880/2 - 1	51.9	16.7	26.4	9110	15.57	83.3	136	5.2	6686	16.70	85.9	75.5	23.0
- 2	19.5	16.0	16.2	6142	16.07	83.2	142	5.1	8611	16.87	84.4	96.5	2.0
- 3	6.3	16.3	38.8	7689	16.97	85.8	142	5.3	7516	16.50	84.2	78.3	15.7
- 4	61.3	16.3	41.2	7902	16.87	83.1	139	5.3	8592	17.50	84.1	97.4	2.4
- 5	28.2	16.3	8.6	7596	16.40	84.6	130	5.2	8783	16.50	84.2	98.2	0.0

EVALUATION OF PAIRCROSSES (FULL SIBS) OF C78 & C80, SALINAS, CA., 1999

(TESTS 599, 1599, 4599)

Variety	Test 599 (NB) %Bolt 8/26	Test 599 (NB) Stand Count Mean	Test 599 (NB) DM %	Test 1599 (VY) Sugar Yield lbs	Test 1599 (VY) Sucrose %	Test 1599 (VY) RJAP %	Test 1599 (VY) Beets/ 100' No.	Test 1599 (VY) VY Score Mean	Test 4599 (Rzm) Sugar Yield lbs	Test 4599 (Rzm) Sucrose %	Test 4599 (Rzm) RJAP %	Test 4599 (Rzm) RZM Resist %	Test 4599 (Rzm) Root Rot %
R880/2-# = RZM R780/2 PX (cont.)													
R880/2 - 6	6.3	16.3	32.8	7354	16.23	84.7	121	4.9	8580	16.10	84.8	91.7	6.7
- 7	49.5	17.3	17.8	8477	16.33	83.0	133	4.6	8268	17.03	84.5	90.8	22.2
- 8	45.0	16.3	26.7	8527	16.40	83.2	139	4.9	8995	17.37	85.4	98.2	11.1
- 9	36.8	13.7	14.7	7765	16.63	83.2	118	5.2	8441	17.90	84.3	83.5	9.5
-10	22.7	14.3	17.0	6148	16.33	81.9	112	5.3	6652	16.50	84.5	79.4	21.5
-11	0.0	15.0	44.4	8024	16.60	83.6	142	5.0	8932	17.23	85.2	93.8	0.0
R880-45-# = RZM R780-45 PX													
R880-45 - 1	12.0	16.7	31.9	8486	15.57	84.4	148	4.3	8552	16.47	83.9	71.3	38.9
- 2	22.6	16.0	51.5	9884	16.07	83.4	152	4.8	6770	16.60	82.6	82.5	13.0
- 3	40.1	15.7	54.6	8019	16.57	82.3	161	4.3	8655	17.03	82.7	79.1	0.0
- 4	2.1	16.0	14.6	7365	16.63	83.5	139	5.1	7315	16.60	85.0	68.7	9.8
- 5	64.9	15.3	17.1	7821	16.53	82.6	136	5.4	7429	16.87	83.4	89.7	0.0
- 6	10.9	15.0	16.0	8949	15.73	83.8	139	4.4	7811	15.60	83.9	87.0	8.1
- 7	2.4	13.7	57.1	9792	16.03	81.5	148	5.0	8155	16.07	82.7	73.9	14.4
- 8	79.2	16.0	20.8	8178	15.77	83.7	136	4.1	8917	16.57	82.8	85.9	9.8
- 9	32.7	15.7	10.3	9507	16.07	84.0	136	4.8	8055	16.87	84.0	88.8	35.2
-10	4.4	15.3	16.9	8214	16.00	82.6	142	4.7	7999	17.33	84.3	95.0	4.2
-11	10.9	15.0	19.7	6102	15.57	84.0	133	5.5	8310	16.70	83.9	85.6	2.4
-12	0.0	15.7	23.2	6926	16.17	82.5	112	4.3	7618	16.70	83.9	51.1	22.2
-13	4.3	15.0	32.3	7582	16.37	83.0	121	5.0	7952	16.73	83.4	72.5	2.1
-14	5.1	14.0	38.8	5220	16.57	82.4	115	4.8	7311	16.63	81.4	88.1	10.3
-15	3.7	7.7	38.0										
R870 -11									8157	16.97	84.6	82.8	15.6

EVALUATION OF PAIRCROSSES (FULL SIBS) OF C78 & C80, SALINAS, CA., 1999

(TESTS 599, 1599, 4599)

	Test 599 (NB)			Test 1599 (VY)					Test 4599 (Rzm)				
Variety	%Bolt 8/26	Stand Count Mean	DM %	Sugar Yield lbs	Sucrose %	RJAP %	Beets/ 100' No.	VY Score Mean	Sugar Yield lbs	Sucrose %	RJAP %	RZM Resist %	Root Rot %
R870-# = RZM R770 PX (cont.)													
R870 - 7	29.6	15.7	49.0						7723	16.33	85.9	69.5	35.8
- 8	46.4	16.3	26.3						9301	17.67	83.1	90.5	3.5
- 9	33.4	16.0	29.9						7154	17.13	82.5	86.7	50.2
-10	13.6	17.3	47.9						8134	16.87	83.9	100.0	24.2
Mean	27.7	15.8	37.1	7926.3	16.17	83.4	141.7	4.9	7851.3	16.69	83.7	85.6	11.6
LSD (.05)	18.8	1.9	28.7	1758.9	0.84	2.5	26.5	0.6	1823.9	0.79	3.2	13.4	26.1
C.V. (%)	42.0	7.3	47.8	13.7	3.20	1.8	11.6	7.5	14.4	2.94	2.4	9.7	138.9
F value	14.5**	3.9**	3.5**	3.7**	2.37**	1.8**	1.8**	3.7**	2.1**	3.57**	1.3NS	5.9**	1.3NS

TEST 599 NOTES: See Tests 1599 and 4599 for performance under virus yellows and rhizomania.

TEST 1599 NOTES: See tests 599 and 4599 for companion tests under bolting and rhizomania conditions. Inoculated with VY (BYV-BWYV-BChV).

TEST 4599 NOTES: Harvested by hand with 5% tare. Lifted roots counted (harvest count), rhizomania susceptible roots counted (% RZM resistant), and root rot counted (*Sclerotium rolfsii*). Total plot weighed but only nonrotted roots used in sugar sample. Also see results from bolting and virus yellows trials.

EVALUATION OF MULTIGERM S_1 PROGENY LINES FROM F_1 POPULATION HYBRIDS, SALINAS, CA., 1999

(TESTS 699, 1699, 4699)

	Test 699 (NB)			Test 1699 (VY)					Test 4699 (Rzm)				
Variety	%Bolt 8/26	Stand Count Mean	DM %	Sugar Yield lbs	Sucrose %	RJAP %	Beets/ 100' No.	VY Score Mean	Sugar Yield lbs	Sucrose %	RJAP %	RZM Resist %	Root Rot %
Checks													
8913-70	21.2	17.3	48.0	7377	14.93	81.3	161	4.3	6862	16.27	82.2	85.9	4.3
8918-12	39.4	15.0	38.8	7627	15.27	80.9	152	3.6	7296	16.47	80.1	84.3	20.4
R886-89-5NB	36.4	16.7	6.1	7450	16.50	83.9	139	4.8	7406	17.13	82.4	78.6	2.2
8935 (Iso)	31.7	16.0	23.0	7258	15.60	82.2	145	4.5	7559	16.43	81.4	63.2	16.2
8939	44.4	15.0	39.4	8307	15.80	86.0	136	4.7	7905	16.43	83.7	76.9	14.6
Y869	44.7	15.0	39.0	10418	16.23	85.0	148	4.3	7250	16.53	85.1	68.3	33.1
97-C37	15.9	16.7	24.1	7035	15.87	84.4	170	4.3					
97-SP22-O	88.0	16.7	36.2	3649	14.87	80.8	164	6.0					
B4776R									10439	17.67	84.8	96.3	2.1
US H11									5134	14.27	81.8	10.5	6.7
US H11									5185	15.13	83.2	23.0	14.7
8935-# = RZM R776-89-5H13⊗ = C913-70 x C76-89-5													
8935 - 1	20.0	16.7	6.3	7240	15.63	80.2	179	4.5	6758	16.97	81.0	84.0	7.0
- 2	22.3	16.3	26.2	7181	14.10	81.8	170	5.0	6236	15.83	80.0	84.3	2.0
- 3	15.7	17.0	68.6	6645	13.87	81.4	148	4.8	7671	16.00	81.6	69.4	13.5
- 4	12.5	16.3	6.1	6097	15.80	80.6	136	4.4	6394	16.57	78.9	73.1	0.0
- 5	16.3	16.0	46.1	10101	15.03	79.4	155	4.2	8039	16.00	81.8	59.3	7.8
- 6	34.2	15.0	20.1	8249	15.17	77.8	130	4.1	6960	16.17	76.9	81.4	0.0
- 7	0.0	16.0	36.6	4722	14.37	80.1	127	4.8	7185	15.77	83.6	70.2	22.3
- 8	21.8	16.7	53.7	8011	15.03	82.1	136	4.2	8124	16.63	87.3	84.9	15.2
- 9	36.1	16.3	65.2	6752	15.23	80.6	145	4.6	6626	16.67	80.1	75.3	4.4
-10	7.7	17.7	41.7	8625	15.53	82.2	152	4.6	7990	16.47	84.3	86.2	0.0
-11	10.8	14.7	7.2	7606	15.60	81.4	142	4.3	6246	16.47	81.6	71.3	0.0
-12	6.1	16.7	42.0	7964	15.33	82.0	152	4.9	8155	16.80	80.7	77.6	12.3

EVALUATION OF MULTIGERM S_1 PROGENY LINES FROM F_1 POPULATION HYBRIDS, SALINAS, CA., 1999

(TESTS 699, 1699, 4699)
(cont.)

	Test 699 (NB)			Test 1699 (VY)					Test 4699 (Rzm)				
Variety	%Bolt	Stand Count	DM	Sugar Yield	Sucrose	RJAP	Beets/ 100'	VY Score	Sugar Yield	Sucrose	RJAP	RZM Resist	Root Rot
	8/26	Mean	%	lbs	%	%	No.	Mean	lbs	%	%	%	%
8935-# = RZM R776-89-5H13⊗ = C913-70 x C76-89-5 (cont.)													
8935 -13	11.1	15.0	8.9	8164	16.03	83.0	145	4.9	7522	16.83	81.1	76.9	0.0
-14	66.3	15.7	19.2	7138	15.93	82.1	148	5.0	6755	16.63	80.5	91.5	0.0
-15	34.4	15.3	34.4	7229	14.77	81.6	148	5.1	7261	15.70	79.5	82.4	8.3
-16	55.4	15.7	55.7	7817	14.83	84.9	133	4.2	6070	15.87	82.5	72.2	7.1
-17	16.5	16.0	24.4	6891	15.97	80.2	133	4.7	6356	17.17	81.4	76.5	8.3
-18	2.2	16.3	57.5	8571	15.27	81.8	145	4.2	5856	16.37	78.9	74.5	33.8
-19	37.9	15.0	11.3	6934	15.47	81.9	133	4.3	6600	17.07	82.6	70.4	0.0
-20	24.0	16.0	52.8	7119	14.70	81.6	145	4.2	5416	15.67	80.4	82.4	14.7
-21	51.4	16.3	24.8	5058	15.33	77.2	124	4.5	4010	16.40	77.4	56.8	2.1
-22	9.6	13.7	72.0	7194	15.70	82.4	133	4.3	7311	16.90	81.2	88.4	4.8
-23	56.7	15.3	34.6	9327	15.17	81.5	145	4.2	8109	16.53	83.4	83.6	9.5
-24	15.0	15.7	50.7	7713	15.97	83.0	148	4.3	8466	16.83	79.6	90.4	11.2
-25	14.4	15.0	9.0	6319	16.83	81.8	161	4.4	7221	17.80	83.0	89.4	1.8
-26	17.9	13.7	0.0	7248	15.40	83.1	136	4.8	6270	16.90	82.2	94.4	0.0
-27	6.5	14.0	5.6	7055	15.93	81.0	142	4.6	7291	16.87	81.2	86.6	2.1
-28	27.8	14.3	42.2	7122	15.20	83.2	127	4.2	5979	16.33	81.2	72.6	0.0
-29	34.5	16.7	44.0	6122	15.23	82.6	139	4.3	8430	15.70	82.9	97.9	3.9
8936-# = RZM R776-89-5H31⊗													
8936 - 1	24.4	16.7	34.3	8105	16.40	84.8	133	4.6	7325	16.57	83.5	47.9	30.3
- 2	82.1	15.3	32.9	6212	13.37	81.3	133	4.6	6756	15.07	81.9	74.0	2.4
- 3	35.9	15.7	25.1	8500	15.30	83.2	139	4.4	7236	16.63	83.2	63.8	12.6
- 4	4.0	16.3	8.1	6407	14.80	82.9	115	4.3	6865	16.27	82.0	52.5	0.0
- 5	31.3	16.0	12.5	7223	15.10	82.0	139	4.0	8379	16.77	81.6	77.4	9.3

EVALUATION OF MULTIGERM S_1 PROGENY LINES FROM F_1 POPULATION HYBRIDS, SALINAS, CA., 1999

(TESTS 699, 1699, 4699)
(cont.)

	Test 699 (NB)			Test 1699 (VY)					Test 4699 (Rzm)				
Variety	%Bolt 8/26	Stand Count Mean	DM %	Sugar Yield lbs	Sucrose %	RJAP %	Beets/ 100' No.	VY Score Mean	Sugar Yield lbs	Sucrose %	RJAP %	RZM Resist %	Root Rot %
8936-# = RZM R776-89-5H31⊗ (cont.)													
8936 - 6	67.2	14.3	21.4	8226	14.90	82.3	130	4.3	7478	16.87	80.6	81.3	12.5
- 7	79.8	15.0	2.4	10205	16.20	83.5	127	4.2	8903	17.07	83.3	59.0	32.1
- 8	4.8	14.7	11.4	6543	18.07	85.5	118	4.8	7536	17.83	81.4	73.8	2.4
- 9	65.9	15.7	21.1	7086	15.67	80.6	142	4.9	6171	15.83	72.7	90.3	0.0
-10	19.0	15.7	55.7	7253	16.77	85.7	139	5.2	8316	17.00	82.5	95.7	13.8
-11	0.0	16.3	53.2	7373	16.30	82.9	124	4.8	8706	16.43	84.0	93.6	2.1
-12	32.6	13.7	48.5	6846	15.47	82.0	115	4.9	7374	16.73	83.4	46.1	5.8
-13	14.2	14.7	46.4	6052	15.53	76.5	130	4.4	4392	16.20	75.0	39.4	2.4
-14	66.7	16.0	14.6	7822	16.00	81.5	142	3.9	6807	17.23	82.0	70.0	23.1
-15	59.5	15.3	21.4	7180	16.03	84.8	133	4.8	8454	16.17	80.2	91.8	0.0
-16	20.0	13.3	0.0	7173	16.90	81.3	127	4.5	7337	16.70	73.7	83.4	6.7
-17	90.5	14.7	31.3	6300	14.07	82.9	136	5.0	7147	16.07	83.3	64.1	4.5
-18	31.1	15.0	100.0	7976	16.50	79.6	142	4.7	6663	17.60	80.1	75.6	0.0
-19	54.4	14.0	15.6	8935	14.97	83.0	118	4.6	9018	16.77	83.0	84.3	0.0
-20	10.7	15.0	13.5	6470	16.30	83.3	133	3.9					
8937-# = R776-89-5H11⊗													
8937 - 1	63.3	15.7	46.0	6978	16.10	83.2	133	4.5	6665	16.53	80.9	47.7	3.7
- 2	58.3	15.3	55.7	4598	15.30	80.8	118	4.7	5658	15.37	83.0	15.1	21.9
- 3	42.9	15.7	0.0	5704	16.23	84.3	130	5.6	6450	16.87	83.2	60.0	10.0
- 4	28.7	15.3	26.0	6901	16.63	81.2	118	4.3	5650	17.10	79.4	40.0	0.0
- 5	37.0	13.3	5.0	6233	16.17	80.9	145	5.2	6201	16.73	82.0	46.7	0.0

EVALUATION OF MULTIGERM S_1 PROGENY LINES FROM F_1 POPULATION HYBRIDS, SALINAS, CA., 1999

(TESTS 699, 1699, 4699)
(cont.)

	Test 699 (NB)			Test 1699 (VY)					Test 4699 (Rzm)				
Variety	%Bolt 8/26	Stand Count Mean	DM %	Sugar Yield lbs	Sucrose %	RJAP %	Beets/ 100' No.	VY Score Mean	Sugar Yield lbs	Sucrose %	RJAP %	RZM Resist %	Root Rot %
8939-# = RZM Y769H31⊗													
8939 - 1	29.2	14.7	24.6	7471	15.27	82.5	136	4.4	7025	16.70	78.7	51.5	2.8
- 2	31.8	14.7	49.1	7667	15.97	84.9	121	5.0	7026	16.53	83.1	88.0	29.9
- 3	2.2	15.7	64.2	6619	15.87	81.4	127	4.5	6879	16.20	82.7	62.7	10.3
- 4	23.1	15.7	15.4	6114	15.23	81.6	152	5.2	7261	16.80	81.2	66.3	0.0
- 5	57.5	15.0	41.1	7207	14.73	83.1	152	5.0	7199	14.53	82.2	41.8	12.3
- 6	45.0	16.3	25.9	6155	14.17	82.0	118	4.7	6759	14.87	83.8	77.8	17.9
- 7	9.2	13.7	32.3	6751	16.13	82.6	112	4.3	6764	16.80	83.1	56.0	27.6
- 8	47.6	14.7	11.3	7158	15.57	81.3	121	4.0	7751	16.17	80.3	83.1	4.4
- 9	45.7	13.0	16.7	6042	14.03	84.8	112	5.1	6225	14.20	85.2	41.3	13.9
-10	38.4	14.0	37.5	6336	13.93	85.6	148	5.3	5787	13.27	84.7	25.6	23.9
-11	26.1	14.0	50.6	6134	16.13	83.9	133	5.0	8325	16.50	81.3	67.9	11.6
-12	34.4	12.0	20.2	8636	16.63	81.2	133	3.8	6579	15.37	78.3	37.6	45.4
-13	59.2	12.3	21.9	8746	15.77	83.1	118	4.6	8552	16.20	82.3	56.9	10.3
-14	30.3	14.3	4.8	6286	15.03	79.7	118	4.9	5637	15.93	79.7	64.1	0.0
-15	29.0	15.0	51.4	6453	16.47	83.1	133	4.6	6673	16.67	83.3	75.4	9.9
-16	2.1	15.0	7.2	6285	15.83	83.7	142	4.5	6008	15.63	74.6	84.9	19.0
-17				7433	15.53	81.2	118	3.8					
-18				9168	15.20	86.1	124	4.1					
CR811-# & CR812-#													
CR811-1	93.6	15.7	38.0						7018	14.60	77.8	86.8	9.0
CR812-1	53.4	15.3	48.1						5728	14.97	81.0	45.9	14.3
Mean	15.3	33.6	31.0	7203.8	15.53	82.2	137.1	4.6	7012.8	16.31	81.4	69.7	9.6
LSD (.05)	2.0	20.9	29.6	1987.6	1.00	3.0	25.0	0.5	1832.3	1.20	4.5	21.5	21.6
C.V. (%)	8.0	38.5	59.1	17.1	3.98	2.3	11.3	7.4	16.2	4.56	3.5	19.1	140.1
F value	2.5**	9.4**	3.7**	2.7**	4.98**	3.0**	2.4**	4.6**	2.7**	3.69**	2.4**	6.3**	1.7**

EVALUATION OF MULTIGERM S_1 PROGENY LINES FROM F_1 POPULATION HYBRIDS, SALINAS, CA., 1999

(TESTS 699, 1699, 4699)

	Test 699 (NB)			Test 1699 (VY)					Test 4699 (Rzm)				
Variety	%Bolt	Stand Count	DM	Sugar Yield	Sucrose	RJAP	Beets/ 100'	VY Score	Sugar Yield	Sucrose	RJAP	RZM Resist	Root Rot
	8/26	Mean	%	lbs	%	%	No.	Mean	lbs	%	%	%	%

TEST 699 NOTES: See Tests 1699 and 4699 for performance under virus yellows and rhizomania. See notes for Test 299.

8935-# = RZM R776-89-5H13⊗ = 6913-70aa x R576-89-5
8936-# = RZM R776-89-5H31⊗ = 6931aa x R576-89-5
8937-# = R776-89-5H11⊗ = 5911-4aa x R576-89-5
8939-# = RZM Y769H31⊗ = 6931aa x Y669
R576-89-5 = C176-89-5 = Inc. of full sib family selected from popn-76-89.
C913-70 = C913-70
6931 = MM,S^f,Aa,*Rz* population
Y669 = C69
5911-4 = C911-4

TEST 1699 NOTES: See tests 699 and 4699 for companion tests under bolting and rhizomania conditions. Inoculated with VY (BYV-BWYV-BChV).

TEST 4699 NOTES: Harvested by hand with 5% tare. Lifted roots counted (harvest count), rhizomania susceptible roots counted (% RZM resistant), and root rot counted (*S. rolfsii*). All roots in plot weighed but only nonrotted roots included in sugar sample. Also see results from bolting and virus yellows trials.

EVALUATION OF MULTIGERM S_1 PROGENY LINES FROM RANDOM-MATED POPULATIONS, SALINAS, CA., 1999

(TESTS 799, 1799, 4799)

	Test 799 (NB)			Test 1799 (VY)					Test 4799 (Rzm)				
Variety	%Bolt	Stand Count	DM	Sugar Yield	Sucrose	RJAP	Beets/ 100'	VY Score	Sugar Yield	Sucrose	RJAP	RZM Resist	Root Rot
	8/26	Mean	%	lbs	%	%	No.	Mean	lbs	%	%	%	%
Checks													
7933	41.1	16.0	23.4										
8931	33.3	17.0	23.6						7614	15.37	84.0	65.5	41.8
8931									8874	16.50	85.9	78.3	26.7
8931									8874	16.50	85.9	78.3	26.7
8931									6642	16.37	84.7	75.8	2.0
8926 (Iso)	32.6	16.7	42.8						7830	15.73	83.8	86.0	12.6
8926									6786	15.07	82.9	59.4	9.8
US H11									4367	13.27	83.8	5.6	21.9
US H11									3879	13.07	85.4	11.9	15.4
8931-# = RZM-ER-%S 6931⊗													
8931 - 1	11.9	16.7	40.3	6608	16.23	82.8	152	5.3	8091	15.80	84.1	79.7	6.3
- 2	2.2	15.7	78.3	6629	16.30	82.2	152	5.8	7304	16.37	81.6	87.2	13.7
- 3	0.0	15.0	2.2	5501	16.13	79.7	158	6.6	7119	16.57	79.4	71.5	0.0
- 4	22.3	16.0	54.7	7777	15.27	84.3	136	5.2	7906	15.43	83.4	83.3	26.6
- 5	0.0	15.7	16.9	8984	16.53	82.1	142	5.1	8749	17.80	87.3	80.9	11.5
- 6	41.7	16.0	45.8	6875	16.67	85.3	158	5.8	7946	15.73	87.3	82.2	21.7
- 7	4.0	16.3	55.1	7927	17.30	82.4	161	5.7					
- 8	83.3	16.0	52.1	6392	15.67	79.7	155	5.3					
- 9	38.9	14.7	86.7	7545	16.47	84.0	139	5.6	7637	15.87	84.7	63.8	9.8
-10	2.1	15.0	68.9	7265	16.03	84.3	136	6.0	7136	15.53	89.5	72.8	11.8
-11	45.3	16.0	64.7	6046	15.83	85.9	152	5.7	7790	15.33	86.1	89.7	3.9
-12	0.0	15.3	24.0	6222	16.07	81.8	145	5.8	6690	16.00	85.0	76.2	5.9
-13	0.0	15.7	27.6	8268	16.23	82.8	145	5.5	8217	15.17	84.0	88.7	28.9
-14	2.1	15.3	14.6	6333	15.83	81.1	142	5.7	7736	15.40	81.8	75.7	6.1
-15	47.6	15.3	61.0	7578	16.53	83.1	130	5.2	8107	15.93	82.3	71.9	16.7
-16	60.1	15.7	25.6	7097	16.20	82.4	139	5.3	7430	15.43	82.8	75.6	12.5

EVALUATION OF MULTIGERM S_1 PROGENY LINES FROM RANDOM-MATED POPULATIONS, SALINAS, CA., 1999

(TESTS 799, 1799, 4799)
(cont.)

	Test 799 (NB)			Test 1799 (VY)					Test 4799 (Rzm)				
Variety	%Bolt	Stand Count	DM	Sugar Yield	Sucrose	RJAP	Beets/ 100'	VY Score	Sugar Yield	Sucrose	RJAP	RZM Resist	Root Rot
	8/26	Mean	%	lbs	%	%	No.	Mean	lbs	%	%	%	%
8931-# = RZM-ER-%S 6931⊗ (cont.)													
8931 -17	66.4	15.0	56.6	7728	16.07	83.1	127	4.5	6762	15.53	84.3	87.3	9.5
-18	90.5	14.7	41.3	6450	15.30	83.2	130	5.8	7266	14.03	84.9	71.6	0.0
-19	48.1	10.7	68.9										
-20	33.4	14.0	28.6	7930	16.77	83.6	130	5.2					
-21	14.0	14.3	28.6	6524	15.77	82.8	127	5.8	5917	15.33	84.6	56.2	15.4
-22	18.6	12.3	15.6	6778	16.27	84.3	142	5.0	6484	16.20	81.1	94.2	6.3
-23	29.9	14.3	9.2	7079	16.10	84.2	124	5.1	7548	14.87	86.3	95.2	21.5
-24	28.9	14.7	37.7	8757	15.67	83.0	139	4.9	6972	15.07	86.0	71.0	22.6
-25	26.6	16.0	12.5						8327	16.73	83.7	78.2	11.8
-26	48.2	15.3	62.2						6638	15.57	84.8	91.5	2.4
-27	8.6	15.3	4.4						9177	15.03	84.9	97.8	12.1
-28	25.3	13.7	32.0						6801	16.37	83.1	87.3	4.4
8926-# = RZM 7926⊗													
8926 - 1	63.1	15.3	32.4	6229	15.00	82.6	145	5.5	7608	15.37	83.7	76.5	0.0
- 2	23.9	15.3	69.6	3989	15.20	80.0	115	5.7	7273	14.00	82.7	72.5	26.7
- 3	76.1	16.7	10.4	6587	16.37	81.2	152	4.5					
- 4	15.7	13.0	60.8						5254	17.30	74.7	94.9	0.0
- 5	27.1	14.7	71.0						7466	16.07	83.4	87.6	11.7
- 6	26.2	14.0	59.5						7126	16.10	82.0	85.8	0.0
- 7	22.4	14.3	67.2						8673	15.60	83.3	100.0	0.0
- 8									6679	15.53	81.9	66.4	20.6

EVALUATION OF MULTIGERM S_1 PROGENY LINES FROM RANDOM-MATED POPULATIONS, SALINAS, CA., 1999

(TESTS 799, 1799, 4799)
(cont.)

	Test 799 (NB)			Test 1799 (VY)					Test 4799 (Rzm)				
Variety	%Bolt	Stand Count	DM	Sugar Yield	Sucrose	RJAP	Beets/ 100'	VY Score	Sugar Yield	Sucrose	RJAP	RZM Resist	Root Rot
	8/26	Mean	%	lbs	%	%	No.	Mean	lbs	%	%	%	%
8933-# = RZM 7221,7225,7227,7933⊗ (Root aphid Res.)													
8933 - 1	42.5	15.0	70.8	5826	16.57	80.7	121	5.6	6495	16.17	81.7	60.4	14.1
- 2	22.2	15.0	44.4						5802	16.83	77.0	41.5	6.7
- 3	45.2	13.3	54.6						4669	14.27	83.0	5.9	24.1
-21	33.4	15.0	47.9	6516	16.43	82.2	103	6.3	5298	15.50	85.5	24.4	33.0
-22	11.0	15.3	35.4	5308	16.03	85.3	127	6.0	3919	13.60	81.5	2.4	38.8
-23	9.1	15.0	41.7						6531	16.30	86.3	59.0	28.6
-31	22.5	16.3	38.2	6138	15.87	83.0	130	5.8	6800	15.53	83.8	93.8	4.2
-32	0.0	16.7	38.0						6689	15.77	84.6	67.2	24.4
-33	37.4	15.7	4.4						5068	15.47	79.0	71.7	5.9
-34	51.0	15.7	23.5						5227	14.30	83.6	70.6	10.1
-41				7225	16.17	84.1	145	5.2					
-42				5501	15.63	82.6	145	4.4					
Mean	15.1	29.9	41.1	6800.4	16.08	82.8	139.0	5.5	6923.3	15.55	83.6	70.7	13.8
LSD (.05)	1.7	19.0	31.7	1830.5	0.57	2.5	25.3	0.5	1731.7	0.93	4.6	22.8	4.6
C.V. (%)	7.0	39.2	47.5	16.5	2.17	1.8	11.2	5.7	15.4	3.67	3.4	19.9	3.4
F value	3.8**	11.4**	3.8**	2.6**	5.95**	3.1**	2.2**	7.7**	4.1**	8.30**	2.5**	8.9**	2.5**

TEST 799 NOTES: See Tests 1799 and 4799 for performance under virus yellows and rhizomania.

TEST 1799 NOTES: See tests 799 and 4799 for companion tests under bolting and rhizomania conditions. Inoculated with VY (BYV-BWYV-BChV).

TEST 4799 NOTES: Harvested by hand with 5% tare. Lifted roots counted (harvest count), rhizomania susceptible roots counted (% RZM resistant), and root rot counted (*Sclerotium rolfsii*). All roots in plot weighed but only roots without rot included in sugar sample. Also see results from bolting and virus yellows trials.

EVALUATION OF MONOGERM S_1 PROGENY LINES FROM RANDOM-MATED POPULATIONS, SALINAS, CA., 1999

(TESTS 899, 1899, 4899)

	Test 899 (NB)			Test 1899 (VY)					Test 4899 (Rzm)				
Variety	%Bolt 8/26	Stand Count Mean	DM %	Sugar Yield lbs	Sucrose %	RJAP %	Beets/ 100' No.	VY Score Mean	Sugar Yield lbs	Sucrose %	RJAP %	RZM Resist %	Root Rot %
Checks													
8835m	52.2	16.3	2.0	8051	16.13	83.6	158	6.3	6132	15.37	82.7	82.9	19.5
8838m	42.9	15.7	2.2	7102	15.50	81.7	161	5.6	4767	15.50	81.2	82.1	30.5
8838-# = RZM 7838mm⊗ (T-O testcrosses)													
8838 - 5	13.7	14.7	2.2	5163	15.60	83.9	145	5.6					
- 6	30.0	13.3	5.1	6196	14.60	78.5	91	5.5	6306	14.47	82.3	45.0	57.5
8835-# = RZM 7835mm⊗													
8835 - 3	13.9	14.7	11.1						3622	14.87	78.2	46.7	36.2
- 4	42.3	13.3	22.3						5430	15.30	79.8	76.4	15.4
- 5	29.2	16.0	8.3						5844	15.57	82.7	65.6	26.4
- 6	45.8	16.7	14.1						6193	14.67	81.5	59.3	29.6
- 7	70.8	15.7	8.8						5842	15.20	81.6	27.3	34.7
- 9	0.0	13.7	2.2						3925	16.00	83.3	87.0	30.0
-10	0.0	13.7	35.7						4845	15.03	80.7	76.2	15.8
-12	7.0	14.3	16.2						5466	15.50	82.9	93.9	49.8
-14	14.9	13.7	4.4						5381	14.73	81.0	70.1	18.8
-15	0.0	14.7	16.1	3255	15.97	80.7	109	5.6	5019	16.27	80.7	65.3	28.0
-16	10.8	15.7	12.9						5341	15.60	81.8	57.0	28.9
-17	2.1	15.3	15.2	3778	15.80	77.8	136	5.5	5157	15.83	80.8	56.3	26.3
-18	69.2	13.0	0.0						4460	15.47	81.8	84.9	30.0

EVALUATION OF MONOGERM S_1 PROGENY LINES FROM RANDOM-MATED POPULATIONS, SALINAS, CA., 1999

(TESTS 899, 1899, 4899)

(cont.)

	Test 899 (NB)			Test 1899 (VY)					Test 4899 (Rzm)				
Variety	%Bolt 8/26	Stand Count Mean	DM %	Sugar Yield lbs	Sucrose %	RJAP %	Beets/ 100' No.	VY Score Mean	Sugar Yield lbs	Sucrose %	RJAP %	RZM Resist %	Root Rot %
8835-# = RZM 7835H69mm⊗													
8835 -21	17.2	13.3	30.0						4381	15.23	80.2	44.8	48.3
-23	32.7	15.3	34.2						5330	15.10	87.7	74.9	22.0
-24	37.7	15.3	11.3						4560	14.90	83.6	78.2	26.2
-25	8.6	15.7	8.3						4538	14.50	82.6	88.2	32.7
-28	41.7	15.3	14.7						6474	14.80	83.4	79.3	24.3
-30	28.9	15.0	24.4						4824	16.37	81.0	100.0	35.9
8835-# = RZM 7835H87mm⊗													
8835 -31	9.9	13.3	2.2						4733	14.43	83.1	92.8	24.5
-33	80.4	15.3	2.2						4948	16.00	82.1	97.8	12.5
-35	0.0	15.3	0.0						4160	15.17	78.6	76.1	9.3
-36	63.0	12.7	27.7						5699	15.33	80.3	77.4	20.0
-38	13.1	15.3	27.6						6087	14.93	81.8	87.8	37.8
-41	31.9	14.3	20.1						5442	16.00	80.7	72.5	30.0
-42	23.1	13.3	45.8						3960	12.70	84.9	27.5	13.3
-45	25.6	15.7	21.1						5913	15.60	80.6	87.9	26.4
-46	4.0	16.7	30.3						4265	14.17	79.9	73.1	17.2
-47	18.4	16.0	23.5	4529	14.40	81.0	152	5.8	5319	15.33	80.8	77.2	21.7
8835-# = RZM 7835mm⊗ (No O-T Testcrosses)													
8835 -51	32.6	15.3	50.1	5708	15.77	81.4	136	6.1	5360	16.67	81.0	86.2	18.4
-52	2.0	15.7	15.0						4655	16.63	80.9	73.0	9.4

EVALUATION OF MONOGERM S_1 PROGENY LINES FROM RANDOM-MATED POPULATIONS, SALINAS, CA., 1999

(TESTS 899, 1899, 4899)

(cont.)

	Test 899 (NB)			Test 1899 (VY)					Test 4899 (Rzm)				
Variety	%Bolt 8/26	Stand Count Mean	DM %	Sugar Yield lbs	Sucrose %	RJAP %	Beets/ 100' No.	VY Score Mean	Sugar Yield lbs	Sucrose %	RJAP %	RZM Resist %	Root Rot %
8835-# = RZM 7835H69mm⊗													
8835 -61	9.0	14.0	37.4						7184	16.07	83.1	83.5	12.5
-62	2.1	14.3	4.2						4721	15.33	84.3	94.1	17.4
8835-# = RZM 7835H87mm⊗													
8835 -71	51.0	15.0	17.4	4886	16.27	81.3	139	6.0	4666	16.03	82.4	76.4	30.7
-72	0.0	16.7	29.7						4381	15.10	79.5	84.4	5.6
-73	57.3	15.7	14.7						6066	15.87	80.4	81.4	42.4
-74	23.9	15.3	6.7						6178	15.97	82.2	60.7	20.6
-75	25.9	14.0	4.8						5565	15.17	82.6	90.6	8.6
-76	10.8	14.0	19.7						5448	15.77	80.6	74.7	10.6
-77	97.8	15.0	0.0						6740	16.17	81.5	76.3	0.0
8828-# = RZM-ER-%S 6828mm⊗													
8828 - 1	56.3	16.0	2.1	6059	16.40	82.1	130	6.3	5899	16.60	83.0	74.1	7.8
- 2	41.9	15.3	0.0	3829	16.00	81.4	121	6.3	5979	16.03	82.1	78.8	0.0
- 3	27.1	15.7	0.0	3902	15.80	80.7	130	5.7	4917	15.97	83.6	69.9	7.8
- 4	4.2	15.7	4.2	5551	16.07	82.5	139	5.8	4880	15.40	84.5	39.8	0.0
- 5	49.2	16.0	10.7	3940	15.50	80.5	158	5.8	6272	16.10	80.9	83.8	1.6
- 6	0.0	14.7	6.5	7142	16.40	85.6	127	5.8	4533	15.67	83.3	68.9	12.5
- 7	13.5	14.7	0.0	3414	14.90	82.6	142	5.3	4829	16.10	78.5	42.2	34.9

EVALUATION OF MONOGERM S_1 PROGENY LINES FROM RANDOM-MATED POPULATIONS, SALINAS, CA., 1999

(TESTS 899, 1899, 4899)

(cont.)

	Test 899 (NB)			Test 1899 (VY)					Test 4899 (Rzm)				
Variety	%Bolt	Stand Count	DM	Sugar Yield	Sucrose	RJAP	Beets/ 100'	VY Score	Sugar Yield	Sucrose	RJAP	RZM Resist	Root Rot
	8/26	Mean	%	lbs	%	%	No.	Mean	lbs	%	%	%	%
8833-# = RZM-ER-%S 6833mm⊗													
8833 - 1	40.1	15.7	11.4	4576	14.50	83.5	139	6.5	5815	15.50	82.8	95.5	5.9
- 2	44.9	17.3	7.9	4794	13.67	81.5	179	6.3	5509	15.33	83.9	89.6	6.3
- 3	41.4	16.0	6.1	4594	13.70	84.4	152	6.4	5347	14.70	82.0	68.4	0.0
- 4	22.3	15.3	0.0	4214	15.33	84.6	148	6.7	5564	15.70	82.6	79.6	24.2
- 5	34.4	16.7	34.7	6105	15.57	83.3	161	5.7	4635	15.87	81.0	72.8	23.7
- 6	60.4	15.3	2.0						3707	14.40	83.9	64.0	19.9
8833-# = RZM-ER-%S 6833%mm⊗													
8833 11	68.3	16.0	4.0	3419	15.40	82.5	145	6.5	6186	16.73	81.2	83.2	7.4
-12	34.7	15.3	19.9						5853	17.20	82.8	66.7	0.0
-13	15.8	15.0	6.4						5950	15.67	79.2	92.6	22.1
-14	22.0	9.8	17.6						5637	15.77	82.2	76.9	0.0
8834-# = RZM-ER-%S 6834%mm⊗													
8834 - 1	22.0	15.3	6.8						7857	16.83	83.6	74.3	20.7
- 2	3.9	16.0	8.1						5535	16.70	83.4	93.0	30.9
- 3	89.5	15.7	4.2						5117	15.90	81.5	74.0	39.8
8836-# = RZM-ER-%S 6836mm⊗													
8836 - 1	0.0	15.3	30.3	6983	16.13	83.8	139	5.8	6406	16.17	83.5	76.1	15.6
- 2	0.0	14.3	9.2	5305	14.93	80.0	121	5.6	5998	15.07	80.8	86.9	12.4
- 3	9.9	13.7	4.9	6556	15.87	83.1	133	6.4	7126	16.50	81.5	89.9	29.2
- 4	8.9	15.3	10.7	5397	16.33	80.3	148	5.4	6329	16.70	81.1	89.9	11.5

EVALUATION OF MONOGERM S_1 PROGENY LINES FROM RANDOM-MATED POPULATIONS, SALINAS, CA., 1999

(TESTS 899, 1899, 4899)

(cont.)

	Test 899 (NB)			Test 1899 (VY)					Test 4899 (Rzm)				
Variety	%Bolt 8/26	Stand Count Mean	DM %	Sugar Yield lbs	Sucrose %	RJAP %	Beets/ 100' No.	VY Score Mean	Sugar Yield lbs	Sucrose %	RJAP %	RZM Resist %	Root Rot %
8836-# = RZM-ER-%S 6836mm⊗ (cont.)													
8836 - 5	0.0	10.0	21.6										
- 6	0.0	15.3	8.3						5583	16.30	81.2	35.7	13.9
- 7	0.0	14.0	19.1						7775	16.90	83.4	89.6	13.5
8837-# = RZM-ER-%S 6837mm⊗													
8837 - 1	42.3	16.7	6.0	6894	15.93	83.9	136	6.2	5488	15.50	83.7	80.3	35.5
- 2	2.0	16.7	0.0	5767	15.73	81.8	155	6.1	5291	15.73	81.2	81.8	5.6
- 3	85.4	16.0	0.0	4948	16.47	82.5	145	5.8	6249	15.70	82.1	93.2	5.6
- 4	17.2	15.3	32.9	7438	16.23	85.4	121	5.5	7487	15.10	83.6	69.5	22.0
- 5	54.8	14.7	2.2	6601	16.23	82.0	127	5.8	6116	16.23	81.5	76.9	0.0
- 6	0.0	15.0	0.0	6719	16.70	81.5	136	5.8	6776	16.90	81.1	79.3	13.5
8808-# = RZM-%S 6808mm⊗													
8808 - 1	48.5	15.3	4.2	4878	15.80	81.4	136	5.8	5525	15.60	84.1	46.0	26.9
- 2	18.3	14.7	4.4	3385	15.10	81.4	139	6.5	5913	15.67	82.4	90.7	15.7
- 3	0.0	16.7	3.9	4507	16.40	80.3	133	6.0	4366	15.77	77.3	80.3	19.0
- 4	35.4	15.3	0.0	3326	15.53	83.6	127	6.3	4739	14.77	84.1	70.4	36.0
- 5	0.0	15.7	0.0	5947	15.57	86.3	142	5.3	4222	15.03	85.1	75.8	41.4
- 6	31.5	16.0	2.1	6557	15.73	82.2	136	5.8	6622	15.60	82.1	87.4	16.4
- 7	47.2	16.3	3.9	6582	15.73	80.7	152	5.3	6406	15.97	83.1	81.9	14.6
- 8	44.4	15.0	8.9	5371	15.50	81.2	158	6.2	5828	16.67	82.8	93.3	23.7
- 9	15.3	15.3	15.4	6617	16.63	81.7	152	5.8	7992	16.70	83.5	77.8	36.8

EVALUATION OF MONOGERM S_1 PROGENY LINES FROM RANDOM-MATED POPULATIONS, SALINAS, CA., 1999

(TESTS 899, 1899, 4899)

(cont.)

	Test 899 (NB)			Test 1899 (VY)					Test 4899 (Rzm)				
Variety	%Bolt 8/26	Stand Count Mean	DM %	Sugar Yield lbs	Sucrose %	RJAP %	Beets/ 100' No.	VY Score Mean	Sugar Yield lbs	Sucrose %	RJAP %	RZM Resist %	Root Rot %
8808-# = RZM-%S 6808mm⊗ (cont.)													
8808 -10	10.0	16.7	2.0	4099	15.80	82.2	121	5.4	5240	16.20	84.3	75.7	25.0
-11	40.1	13.7	0.0	5151	15.60	84.2	130	5.8	6316	14.93	85.2	86.4	36.7
-12	2.1	15.3	4.5	6268	16.17	82.9	121	5.5	4969	15.93	82.1	68.6	0.0
-13	6.8	14.0	9.7	2988	15.67	84.7	106	6.0	5739	15.97	83.7	100.0	43.9
-14	0.0	15.7	10.7	2451	15.53	84.6	145	5.3	4316	14.90	82.8	50.9	23.9
-15	0.0	15.3	4.2	3886	16.60	86.6	145	4.9	6434	16.50	85.3	89.7	11.8
-16	0.0	13.3	17.8						7209	16.00	84.2	80.8	2.0
-17	0.0	5.3	4.8										
-18	27.9	13.0	15.0						4876	15.60	81.9	86.6	0.0
-19	28.5	14.0	14.4										
Checks													
8833	69.2	13.7	18.3						4906	15.37	83.7	84.6	18.0
8869	28.8	15.0	23.5						5169	15.87	81.0	89.9	14.8
8848M	20.8	15.7	6.7						6597	15.67	82.6	77.2	30.7
8810M	17.1	15.7	12.5						5963	15.77	82.0	85.4	22.9
8869M									3920	15.43	82.9	164	5.8
R836									6716	14.83	80.6	84.6	15.3
US H11									3982	14.27	85.6	20.0	33.6
8815-# = RZM-%S 6815mm⊗													
8815 - 1	6.3	16.3	3.7						4319	15.47	80.1	80.6	28.4
- 2	27.1	16.0	2.0						5843	15.93	83.3	71.8	36.9
- 3	12.2	15.7	8.9						3571	15.77	78.7	66.7	33.3

EVALUATION OF MONOGERM S_1 PROGENY LINES FROM RANDOM-MATED POPULATIONS, SALINAS, CA., 1999

(TESTS 899, 1899, 4899)
(cont.)

	Test 899 (NB)			Test 1899 (VY)					Test 4899 (Rzm)				
Variety	%Bolt 8/26	Stand Count Mean	DM %	Sugar Yield lbs	Sucrose %	RJAP %	Beets/ 100' No.	VY Score Mean	Sugar Yield lbs	Sucrose %	RJAP %	RZM Resist %	Root Rot %
8817-# = RZM-%S 6817mm⊗													
8817 - 1	9.9	16.3	0.0						5880	15.77	85.5	95.2	17.8
- 2	22.9	16.0	10.4						5227	15.40	82.5	93.3	34.9
- 3	0.0	14.7	13.8						4733	15.90	81.5	89.7	10.6
- 4	4.4	13.7	20.9						7099	16.53	80.7	72.3	21.2
- 5	2.4	14.0	42.1						6605	14.53	81.7	88.0	25.2
8818-# = RZM-%S 6818mm⊗													
8818 - 1	15.0	15.0	6.5						5787	15.13	84.3	88.3	49.5
- 2	58.2	13.0	2.6						6721	15.73	82.3	83.3	34.7
- 3	67.5	14.3	11.6						5167	15.00	81.9	88.9	27.1
- 4	2.6	13.3	0.0						6765	15.67	83.2	100.0	32.8
- 5	2.6	13.3	2.4						5378	15.67	80.9	80.3	14.1
- 6	0.0	14.3	5.1						6352	16.17	78.9	85.4	22.2
- 7	68.4	13.7	2.8						5053	14.00	80.6	85.1	36.5
- 8	42.7	14.0	4.5						5518	15.43	78.9	100.0	19.8
8819-# = RZM-%S 6819mm⊗													
8819 - 1	0.0	15.3	4.3						4181	14.37	80.8	75.9	5.9
- 2	10.3	15.7	0.0						5941	15.70	82.4	61.4	11.5
- 3	13.3	15.7	25.1						5600	15.90	82.0	96.2	12.5
- 4	3.7	16.7	5.6						6091	15.20	82.3	91.7	9.1
8820-# = RZM-%S 6820mm⊗													
8820 - 1	11.8	17.3	7.7						5274	14.53	81.3	62.2	34.1
- 2	0.0	17.3	50.2						4607	16.00	80.2	95.8	5.9
- 3	2.1	16.0	0.0						3871	16.10	81.0	4.8	56.8
- 4	12.3	16.3	10.4						3953	15.80	78.9	81.9	28.5

EVALUATION OF MONOGERM S_1 PROGENY LINES FROM RANDOM-MATED POPULATIONS, SALINAS, CA., 1999

(TESTS 899, 1899, 4899)

(cont.)

	Test 899 (NB)			Test 1899 (VY)					Test 4899 (Rzm)				
Variety	%Bolt 8/26	Stand Count Mean	DM %	Sugar Yield lbs	Sucrose %	RJAP %	Beets/ 100' No.	VY Score Mean	Sugar Yield lbs	Sucrose %	RJAP %	RZM Resist %	Root Rot %
8821-# = RZM-%S 6821mm⊗													
8821 - 1	30.7	15.3	17.6						4970	15.87	83.2	53.8	44.4
- 2	3.9	17.0	0.0						5493	15.27	83.9	28.6	68.6
- 3	69.4	16.3	2.0						3598	16.60	86.5	66.7	58.4
- 4	13.9	16.0	35.7						3896	14.40	75.3	78.3	40.2
Mean	24.2	15.0	11.6	5182.2	15.68	82.4	139.0	5.9	5455.6	15.57	82.0	75.3	22.3
LSD (.05)	17.6	2.1	19.7	1279.9	0.71	3.3	23.6	0.8	2209.2	1.07	3.3	26.5	30.3
C.V. (%)	45.1	8.6	105.7	15.2	2.78	2.5	10.5	8.1	25.2	4.25	2.5	21.9	84.4
F value	13.9**	3.8**	2.7**	9.0**	7.25**	2.5**	3.6**	2.0**	1.5**	3.69	2.5**	3.7**	1.7**

<u>TEST 899 NOTES</u>: See Tests 1899 and 4899 for performance under virus yellows and rhizomania.

<u>TEST 1899 NOTES</u>: See test 899 and 4899 for companion tests under bolting and rhizomania conditions. Inoculated with VY (BYV-BWYV-BChV).

<u>TEST 4899 NOTES</u>: Harvested by hand with 5% tare. Lifted roots counted (harvest count), rhizomania susceptible roots counted and % RZM resistant calculated, and root rot counted (*Sclerotium rolfsii*). All roots in plot weighed but only nonrotted roots used in sugar sample. Also see results from bolting, virus yellows, and Brawley trials.

HYBRID PERFORMANCE OF MONOGERM S_1 PROGENY LINES, SALINAS, CA., 1999

(TESTS 999, 2099, 2399, 5599, B799)

	Test 2399 (Yield)			Test 999 (NB)		Test 2099 (VY)		Test 5599 (Rzm)			Test B799 (IV)	
Variety	Sugar Yield	Sucrose	RJAP	Bolting	DM	Sugar Yield	Sucrose	Sugar Yield	Sucrose	RJAP	Sugar Yield	Sucrose
	lbs	%	%	%	%	lbs	%	lbs	%	%	lbs	%
Checks												
Rifle	13365	17.44	84.4			9866	16.55	8093	18.02	85.9	8420	13.08
B4776R	15419	17.98	85.2	55.9	2.2	11277	16.84	9847	17.30	87.0	7967	11.60
Y869H50	14788	16.49	84.8	54.5	6.0	11154	16.04	6663	15.70	84.4	6872	11.08
Y869H46	14548	16.81	83.9	34.6	22.8	10410	15.79	6634	16.88	86.0		
S_1 lines from popn-833												
Y869H35	13681	16.50	83.2					7963	17.13	87.0	8130	12.32
Y869H5	13336	17.25	82.4	23.2	34.2	11727	16.05	9227	17.73	85.5	6185	11.81
Y869H33-1	11503	16.19	83.1	53.8	10.3			6091	16.58	86.6	6453	10.52
Y869H33-3	12757	16.76	83.1	71.3	10.3	10614	15.32	8298	17.53	86.5	8029	11.68
Y869H33-10	14527	16.69	83.9	32.6	10.2	11237	16.41	7001	17.50	85.4	7162	12.63
Y869H33-11	14224	16.16	83.0	32.6	15.9			6528	17.02	86.6	7193	11.86
Y869H33-12	12707	15.94	83.6	64.0	2.1	10466	15.80	8374	17.13	85.4	6564	11.68
Y869H12	11976	16.25	84.5	61.7	9.0						7298	11.99
S_1 lines from popn-834												
Y869H29	12541	16.25	83.2	14.7	0.0						6340	12.49
Y869H34-1	12710	16.49	83.5	18.8	3.7			6977	16.67	86.2	6650	11.24
Y869H34-2	12789	16.65	82.9	56.8	13.2	9184	16.08	6424	17.25	84.5	7297	11.89
Y869H34-3	13397	16.71	81.8	29.0	23.4			7429	17.28	83.7	6658	11.74
Y869H34-5	13489	15.76	84.0	62.0	19.7			6707	16.55	86.1	6625	11.22
Y869H34-8	13107	16.09	84.7	65.2	21.1	9890	15.51	7307	16.98	85.6	7972	11.76
S_1 lines from popn-828												
Y869H28-9	13242	15.48	83.8	18.9	8.8			6853	15.38	86.7	7673	11.85
Y869H28-10	13665	16.01	84.7	21.6	3.9			5366	15.85	87.5	7742	12.31

HYBRID PERFORMANCE OF MONOGERM S_1 PROGENY LINES, SALINAS, CA., 1999

(TESTS 999, 2099, 2399, 5599, B799)

(cont.)

	Test 2399 (Yield)			Test 999 (NB)		Test 2099 (VY)		Test 5599 (Rzm)			Test B799 (IV)	
Variety	Sugar Yield	Sucrose	RJAP	Bolting	DM	Sugar Yield	Sucrose	Sugar Yield	Sucrose	RJAP	Sugar Yield	Sucrose
	lbs	%	%	%	%	lbs	%	lbs	%	%	lbs	%
S_1 lines from popn-869												
Y869H69	13219	16.06	84.3	39.7	14.9	10644	15.79	7535	16.92	85.2	6469	11.32
Y869H69- 1	13448	16.21	82.8	53.9	20.1			8820	17.00	86.7	8299	11.37
Y869H69- 2	13923	15.90	84.0	59.7	4.0	10268	15.20	7510	17.22	85.3	6926	12.06
Y869H69- 4	12530	16.71	82.3	67.5	9.5	10622	15.95	6734	16.70	85.0	7032	12.14
Y869H69- 5	12721	15.76	84.3	49.5	18.7			8037	16.80	88.1	7300	11.90
Y869H69- 6	12834	16.44	83.4	26.3	19.9			7498	16.38	84.7	7543	12.31
Y869H69- 7	13278	16.81	83.0	17.1	2.1			7870	17.30	86.0	6730	11.54
Y869H69-13	14662	16.41	84.2	35.7	2.2			8112	16.92	85.2	7348	11.55
Y869H69-19	13928	16.00	85.9	49.6	12.5			6647	16.15	85.6	7569	11.57
Y869H69-20	13688	16.56	84.0	30.7	22.6			7757	17.00	84.4	6908	12.10
Y869H69-20B	13485	16.14	79.7	39.7	14.1	9676	15.69	8051	16.73	85.2	6890	11.16
Y869H69-24	12780	16.61	84.6	44.7	15.7	10500	16.10	5447	17.40	86.5	7725	12.45
S_1 lines from popn-836												
Y869H38	12862	15.71	83.5					7895	16.13	85.2	8106	12.32
Y869H36- 3	12829	16.21	82.2	34.3	9.9	9585	15.64	7800	16.80	85.6	7270	11.88
Y869H36-11	13477	16.33	82.7	49.2	16.0			8818	16.97	87.1	7789	11.91
Y869H36-14	12558	16.45	83.8	29.9	14.6			8882	17.27	86.2	7313	12.09
S_1 lines from popn-837												
Y869H77-1	13222	16.31	83.2	27.5	13.3			8577	17.13	86.0	7048	12.39
Y869H77-1B	13012	16.29	82.8	25.4	14.0			7975	16.75	86.8	6756	11.83
Y869H77-2	13599	16.25	81.2	45.2	2.1			7511	16.67	83.8	6750	12.74
Y869H77-3	13713	16.16	83.1	54.2	4.2			6990	16.90	85.3	7004	12.60
Y869H77-4	12143	16.01	83.7	55.6	2.6			8317	16.08	84.6	5591	11.47

HYBRID PERFORMANCE OF MONOGERM S_1 PROGENY LINES, SALINAS, CA., 1999

(TESTS 999, 2099, 2399, 5599, B799)

(cont.)

	Test 2399(Yield)			Test 999(NB)		Test 2099(VY)		Test 5599(Rzm)			Test B799(IV)	
Variety	Sugar Yield	Sucrose	RJAP	Bolting	DM	Sugar Yield	Sucrose	Sugar Yield	Sucrose	RJAP	Sugar Yield	Sucrose
	lbs	%	%	%	%	lbs	%	lbs	%	%	lbs	%
S_1 lines from popn-839												
Y869H79-1	12545	16.11	83.3	43.8	12.5			7633	16.63	83.8	6896	11.38
Y869H79-2	12537	15.41	83.6	50.5	2.1	10419	15.54	7211	16.30	86.9	7561	11.67
Y869H79-3	13459	16.38	84.6	39.9	18.6	9839	15.49	7777	16.95	86.5	6736	10.57
Y869H79-4	11858	16.47	83.4	41.4	10.4			6943	16.48	85.4	6706	11.53
Y869H79-5	13819	16.31	83.4	54.2	8.5			8112	17.02	87.3	7935	11.62
Y869H79-5B	13888	16.65	83.7	52.0	7.6			8150	16.90	86.4	6966	11.98
Y869H79-6	13242	16.40	84.9	26.3	14.6			6812	16.58	86.1	6401	11.97
Y869H79-10	13886	15.80	82.8	30.6	11.0			7913	16.02	86.2	7492	11.80
S_1 lines from popn-831-4												
Y869H4	13614	16.39	83.6	41.5	24.6						7362	11.97
Y869H27-1	13113	16.38	82.9	22.9	14.7	9617	15.69	8481	17.42	84.8	7200	11.29
Y869H27-2	13739	16.14	82.1	31.1	11.1			8136	17.15	87.0	7506	11.12
Y869H27-7	14040	16.39	81.8	7.0	6.8	11481	15.77	9879	17.40	84.4	6465	11.15
Y869H27-8	13328	16.19	83.4	23.2	23.3	10438	15.66	9505	17.20	86.7	8824	11.90
Y869H27-9	12640	16.51	81.1	10.6	9.4			9796	17.80	82.6	6077	11.31
Y869H27-10	13953	16.25	81.8	28.3	7.1	11896	16.04	10574	17.70	85.5	7373	11.37
S_1 lines from popn-808												
Y869H9-1	13826	16.14	84.2	45.0	4.6			8394	17.00	86.7	7734	12.26
Y869H9-2	13911	16.67	83.6	61.7	14.3			7065	17.00	87.6	7298	12.23
Y869H9-3	13697	16.81	82.2	19.3	0.0			6945	16.63	84.8	7202	12.39
Y869H9-4	12914	16.09	84.1	21.3	16.0			8007	17.25	87.0	7142	13.11
Y869H9-7	13890	15.81	83.0	10.8	8.6			7855	16.60	85.6	6299	11.37
Y869H9-8	13002	15.90	84.4	14.8	0.0			7123	16.17	87.2	6337	10.78
Y869H9-9	12542	16.46	84.3	37.7	16.4			7388	16.38	86.1	6415	12.74

HYBRID PERFORMANCE OF MONOGERM S_1 PROGENY LINES, SALINAS, CA., 1999

(TESTS 999, 2099, 2399, 5599, B799)

(cont.)

Variety	Test 2399(Yield)			Test 999(NB)		Test 2099(VY)		Test 5599(Rzm)			Test B799(IV)	
	Sugar Yield	Sucrose	RJAP	Bolting	DM	Sugar Yield	Sucrose	Sugar Yield	Sucrose	RJAP	Sugar Yield	Sucrose
	lbs	%	%	%	%	lbs	%	lbs	%	%	lbs	%
S_1 lines from popn-808 (cont.)												
Y869H9-12	12633	15.21	83.1	45.4	13.1			7438	15.73	86.5	8216	12.07
Y869H9-13	13270	16.02	83.4	30.6	3.9			8208	17.33	87.1	6974	11.77
Y869H9-16	12132	15.76	85.1	26.2	4.4			7038	15.65	86.5	5174	11.02
S_1 lines from popn-818												
Y869H15-1B	13119	16.66	83.0	37.5	4.8			7552	17.00	86.2	7908	12.01
Y869H15-2B	13648	16.21	82.3	20.4	5.9			8407	16.95	84.5	7064	11.48
Y869H15-1	13361	16.41	83.0	30.1	18.5			7803	16.85	84.1	6631	12.65
Y869H15-2	12745	15.96	82.4	18.8	32.1			7794	16.80	83.7	8438	12.23
Y869H15-6	13384	15.96	80.3	4.2	18.6			7474	16.40	84.3	7618	12.44
Y869H15-21	12687	15.97	83.4	9.2	21.6			8174	16.88	85.1	6928	12.48
Mean	13279.1	16.29	83.3	36.0	12.1	10493.7	15.84	7712.7	16.80	85.8	7183.2	11.86
LSD (.05)	1899.2	0.71	2.3	22.7	19.1	927.0	2.49	1407.0	0.77	2.5	1342.3	0.96
C.V. (%)	10.3	3.13	2.0	39.2	97.7	6.3	1.76	13.1	3.29	2.1	13.4	5.79
F value	1.1NS	2.89**	1.8**	3.7**	1.2NS	4.9**	7.73**	4.0**	4.56**	1.5*	2.1**	2.68**

SUGAR BEET RESEARCH

1999 REPORT

Section B

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Colorado Agricultural Experiment Station

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Beet Sugar Development Foundation
(Projects 440, 441, 443, 903, and 904)

CONTENTS

USDA-ARS-NPA Sugar Beet Research Unit's Mission Statement

Utilize distinctive site environmental and disease-free characteristics and specifically developed team expertise to: develop new knowledge and adapt biotechnologies to modify host-pathogen relations that affect disease resistance, pathogenesis, and epidemiology in sugar beet and other plant species pertinent to sugar beet cultivation; discover new information and techniques to identify and produce genotypes exhibiting superior disease and stress tolerance and agronomic qualities; and provide new knowledge that improves production efficiency and biochemical processing characteristics of sugar beet.

USDA-ARS -NPA COLORADO-WYOMING RESEARCH COUNCIL

The Sugar Beet Research Unit is a part of the Colorado-Wyoming (CO-WY)Research Council. This Council was chartered to promote and coordinate cooperative research activities among CO-WY Council research units; and facilitate communication and interaction with the Northern Plains Director, and among research programs and units and with customers locally, regionally, nationally and internationally. The five research units listed below publish an annual compilation of research reports. Many of the units are considering or have placed these reports on individual home pages which can be accessed through the NPA home page at **www.npa.ars.usda.gov**.

Rangeland Resource Research Unit (RRRU) - Cheyenne, WY, Fort Collins, CO & Nunn, CO
MISSION STATEMENT: The mission of the Rangelands Resources Research Unit is to develop an understanding of the interrelationships of the basic resources that comprise rangeland ecosystems. Research is directed toward the development of science and technology that contributes to enhanced forage and livestock production and sustainable, productive rangelands in the Central Great Plains.

Central Plains Resources Management Research Unit (CPRMRU)- Akron CO.
MISSION STATEMENT: To enhance the economic and environmental well-being of agriculture by development of integrated cropping systems and technologies for maximum utilization of soil and water resources. Emphasis is on efficient use of plant nutrients, pesticides, and water and soil conservation/preservation.

Great Plains Systems Research Unit (GPSRU) - Fort Collins, CO.
MISSION STATEMENT: Help develop and implement sustainable and adaptive agricultural systems by: (1) synthesizing, quantifying, evaluating, and enhancing knowledge of processes; (2) developing integrated models of agricultural systems; (3) providing technology packages to agricultural communities and action agencies.

Soil-Plant-Nutrient Research Unit (SPNRU) - Fort Collins, CO.
MISSION STATEMENT: To develop and evaluate new knowledge required to efficiently manage soil, fertilizer and plant nutrients (emphasis on nitrogen) to achieve optimum crop yields, maximize farm profitability, maintain environmental quality and sustain long-term productivity.

Water Management Resources Unit (WMRU) - Fort Collins, CO.
MISSION STATEMENT: Research emphasis is to integrate applied and basic principles to develop improved water, chemical, and alternative weed management systems and irrigation system designs. Improvements are directed toward sustainable, environmentally sound and efficient systems based on soil, water, fertility, energy, and weed ecology principles. This encompasses understanding physical and biological phenomena and developing computer simulation models and precision farming systems to transfer new technologies to producers, consultants, action agencies, industry, and scientists.

For a copy of the Colorado-Wyoming (CO-WY)Research Council Annual Report or information on any of these programs, please note the following contacts:

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PUBLICATIONS & ABSTRACTS

1. Panella, L. Long Term Performance of Artificially Inoculated Cercospora Leaf Spot Nurseries. pp. 123, *In*: xyz (eds.) Cercospora . Advances in Sugar Beet Research, vol.2, IIRB, Brussels, Belgium. 1999. (in press)

2. Panella, L. and L. Frese. Cercospora resistance in *Beta* species and the development of resistant sugar beet lines. pp. 123, *In*: xyz (eds.) Cercospora . Advances in Sugar Beet Research, vol.2, IIRB, Brussels, Belgium. 1999 (in press)

3. Panella, L. Evaluation of *Beta* PIs from the USDA-ARS NPGS for resistance to Cercospora leaf spot, 1999. Biological and Cultural Test for Control of Plant Diseases. Am. Phytopathol. Soc. Vol.15: 2000. (Accepted 12/10/99).

4. Panella, L. Evaluation of *Beta* PIs from the USDA-ARS NPGS for resistance to curly top virus, 1999. Biological and Cultural Test for Control of Plant Diseases. Am. Phytopathol. Soc. Vol.15: 2000. (Accepted 12/10/99).

5. Panella, L. Evaluation of *Beta* PIs from the USDA-ARS NPGS for resistance to Rhizoctonia root rot, 1999. Biological and Cultural Test for Control of Plant Diseases. Am. Phytopathol. Soc. Vol.15: 2000. (Accepted 12/10/99).

6. Panella, L. Evaluation of Rhizoctonia-root-rot-resistant germplasm released by the USDA-ARS Sugar Beet Research Unit over 30 years, 1999. Biological and Cultural Test for Control of Plant Diseases. Am. Phytopathol. Soc. Vol.15: 2000. (Accepted 12/10/99)

7. Panella, L. USDA-ARS Sugar Beet Research at Fort Collins – In it for the Long Haul! Sugar J. 11: March, 2000. (Popular Press)

8. Panella, L. Screening Sugar Beet Germplasm for Rhizoctonia Root Rot Resistance. Agr. Abstr. p. (ASA-CSSA-SSSA Annual Meeting, 31 Oct - 4 Nov, Salt Lake City, UT). 1999. (poster)

9. Wickliffe, E., Otto, K., Schwartz, H.F., Brick, M. A., Ogg, B., Byrne, P., Fall, A., Panella, L., and Hill, A. Fusarium will variability in dry bean and sugarbeet. 15th Biennial Meeting of the Bean Improvement Cooperative, Calgary, Canada, Nov. 8-12, 1999. (poster)

10. Weiland, John J., Robert T. Lewellen, J. Mitch McGrath, Lee Panella, and Ming H. Yu. Tagging of disease resistance genes in sugarbeet (*Beta vulgaris* L.) with molecular genetic markers. Plant & Animal Genome VIII Conference, San Diego, CA, January 9-12, 2000. (Abstract)

EVALUATION OF CONTRIBUTED LINES FOR RESISTANCE TO *RHIZOCTONIA SOLANI*, A CAUSAL FUNGUS OF SUGAR BEET ROOT ROT. (BSDF Project 903)

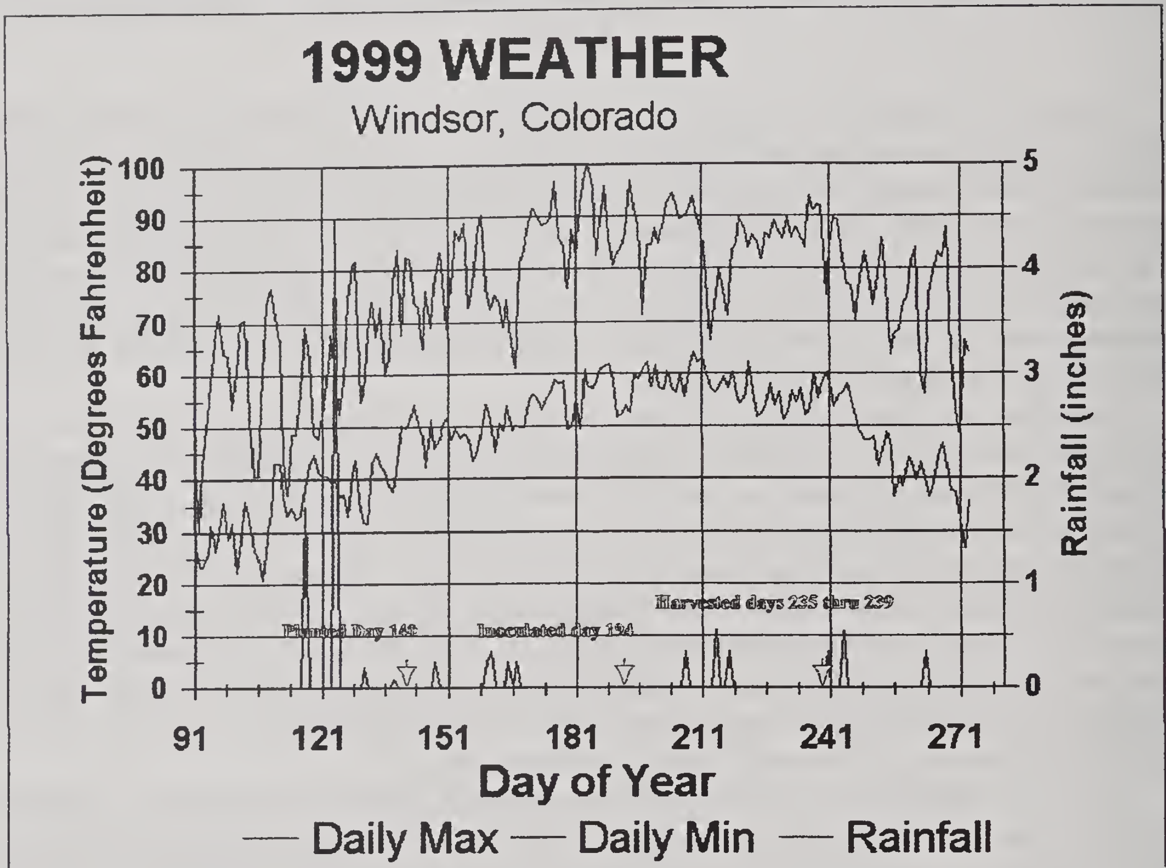
L. Panella

Annually, for over thirty years, the breeding program in Fort Collins has created an artificial epiphytotic through inoculation with *Rhizoctonia solani* to evaluate and select for resistance to root rot caused by this pathogen. We have been pleased to participate and lead this cooperative research project between the ARS, Colorado State University, and the BSDF. The project primarily involved field studies conducted on 35 acres of leased land near Windsor, CO. Randomized, complete-block designs with five replicates were used to evaluate Fort Collins ARS breeding germplasm. Rhizoctonia-resistant line FC703 and highly susceptible FC901/C817 were included as internal controls, along with highly resistant FC705-1.

One-row plots, planted May 20th, were 12 feet long with 22 inches between rows and 8-10 inches within-row spacing. Inoculation with dry, ground, barley-grain inoculum of *Rhizoctonia solani* isolate R-9 was performed on July 13th; immediately after inoculation, a cultivation was performed so as to throw soil into the beet crowns. The field was sprayed twice with Betamix Progress, Upbeet, and Stinger (June 2 and 12) to control weeds. The field was thinned by hand and irrigated as necessary. Beets were harvested August 23 through 27. Each root was rated for rot on a scale of 0 to 7 (dead) as previously described. ANOVAs were performed on disease indices (DIs), percent healthy roots (classes 0 and 1 combined), and percentage of roots in classes 0 thru 3. Percentages were transformed to arcsin-square roots to normalize the data for analyses. LSDs are provided for comparing entries with those of our internal checks.

We had unusually heavy spring rainfall before planting and were able to plant to moisture. We also had just a little rain in the week after planting with warming temperatures (Figure 1). Therefore, stands were excellent and the 1999 Rhizoctonia epidemic started strong and progressed quickly, becoming severe by mid August. Differences in DIs among entries in all tests were highly significant ($P < 0.001$). Mean DIs across all tests for highly resistant FC705-1, resistant FC703, and the highly susceptible check were 3.3, 3.9, and 6.2, respectively. Percentages of healthy roots were 17.8, 9.5, and 0.5 for these internal controls. Percentages of roots in disease classes 0 thru 3 were 56.3, 38.0, and 4.0, respectively. The highest and lowest DIs for evaluated lines were 6.8 and 2.0, respectively.

USDA-ARS 1999 Rhizoctonia Disease Nursery, Fort Collins, CO.



<u>Figure 1 & Table 1.</u> **1999 Rhizoctonia Root Rot Nursery, Fort Collins, CO. The Graph above summarizes the weather data for our Rhizoctonia Root Rot Nursery in 1999. The table below presents summary data of the entire nursery. The experiment mean, the mean of the susceptible check, the mean of the resistant check, and the mean of the highly resistant check are given for each of the experiments in the nursery. LSD is at the t=0.05 level.**

	Disease Index					Percent Healthy (classes 0 & 1)					Percent in Classes 0 to 3				
Exp.	Mean	Sus.	Res.	H Res.	LSD	Mean	Sus.	Res.	H Res.	LSD	Mean	Sus.	Res.	H Res.	LSD
1R	5.0	6.2	3.8	3.4	.80	8	0	8	22	13.2	21	6	44	48	15.2
3R	4.6	6.0	3.6	3.5	.75	5	0	6	16	11.5	22	2	50	58	17.3
4R	4.1	5.9	3.8	3.3	.90	13	0	12	22	14.5	39	2	42	56	18.2
5R	5.7	6.4	4.2	3.1	.63	3	0	8	28	9.4	9	4	30	58	12.6
7R	5.2	6.5	3.9	2.9	.69	5	0	16	26	10.6	13	2	34	64	14.1
8R	5.6	6.2	4.1	3.4	.67	2	2	10	0	8.5	9	8	32	56	14.3
9R	4.7	6.2	4.0	3.8	.73	9	0	4	0	9.1	28	4	30	40	15.4
10R	4.2	6.0	3.7	2.8	.87	12	2	12	28	14.9	36	4	42	70	18.9
Avg.	4.9	6.2	3.9	3.3		7.1	0.5	9.5	17.8		22.1	4.0	38.0	56.3	

Percent in Classes is the transformed value (arcsin-square root)

Mean = Experiment Mean;

Sus. = Susceptible Check (FC901/C817);

Res. = Resistant Check (FC703);

H Res. = Highly Resistant Check (FC705/1)

EVALUATION OF CONTRIBUTED LINES FOR RESISTANCE TO *CERCOSPORA BETICOLA*, CAUSAL FUNGUS OF CERCOSPORA LEAF SPOT (BSDF Project 904)

L. Panella

The breeding program in Fort Collins has created an artificial epiphytotic through inoculation with *Cercospora beticola* annually for over forty years to evaluate and select for resistance to leaf spot caused by this pathogen. We have been pleased to participate and lead this cooperative research project between the ARS, Colorado State University, and the BSDF. The project primarily involved field studies conducted on 35 acres of leased land near Windsor, CO.

Randomized complete-block designs, with three replications were used to evaluate commercial and experimental entries. Internal controls included a highly susceptible synthetic and a resistant check (FC 504/502-2//SP6322-0). The nursery was planted on April 29th. Fertilization was 75% of the soil test recommendation to minimize leaf growth, which can interfere with visual evaluations. Differences among lines were highly significant in all tests at each of three evaluation dates. Two-row plots were 12 feet long, with 22-inch row spacing and an 8 - to 10-inch within-row plant spacing. The trial was planted on April 20th in Windsor, CO. Inoculation was performed on June 30th and again on July 7th. Evaluations were made on September 7th, 14th, and 22nd, with the peak of the epidemic occurring on or about the last date. The field was sprayed twice with Betamix Progress, Upbeet, and Stinger (May 14th and 24th) to control weeds. The field was thinned by hand and irrigated as necessary.

We had good spring rain in 1999 and emergence was excellent and we got off to an early start. The 1999 leaf spot epidemic started strong and progressed rather slowly, but eventually became more severe by late August. We had a period between of about one month right after inoculation, in which we had relatively high evening temperatures (Figure 2), which helped disease development, however by September or evening temperatures had dropped. At our third evaluation, means of the resistant and susceptible internal controls were 3.1 and 6.4 (scale of 0-10), respectively, across the nursery. In 1998 (September 8), these means were 3.2 and 5.3, respectively. Means of contributor lines on September 22 ranged from 2.7 to 9.0, compared with 2.5 to 8.0 in the milder epidemic of 1998.

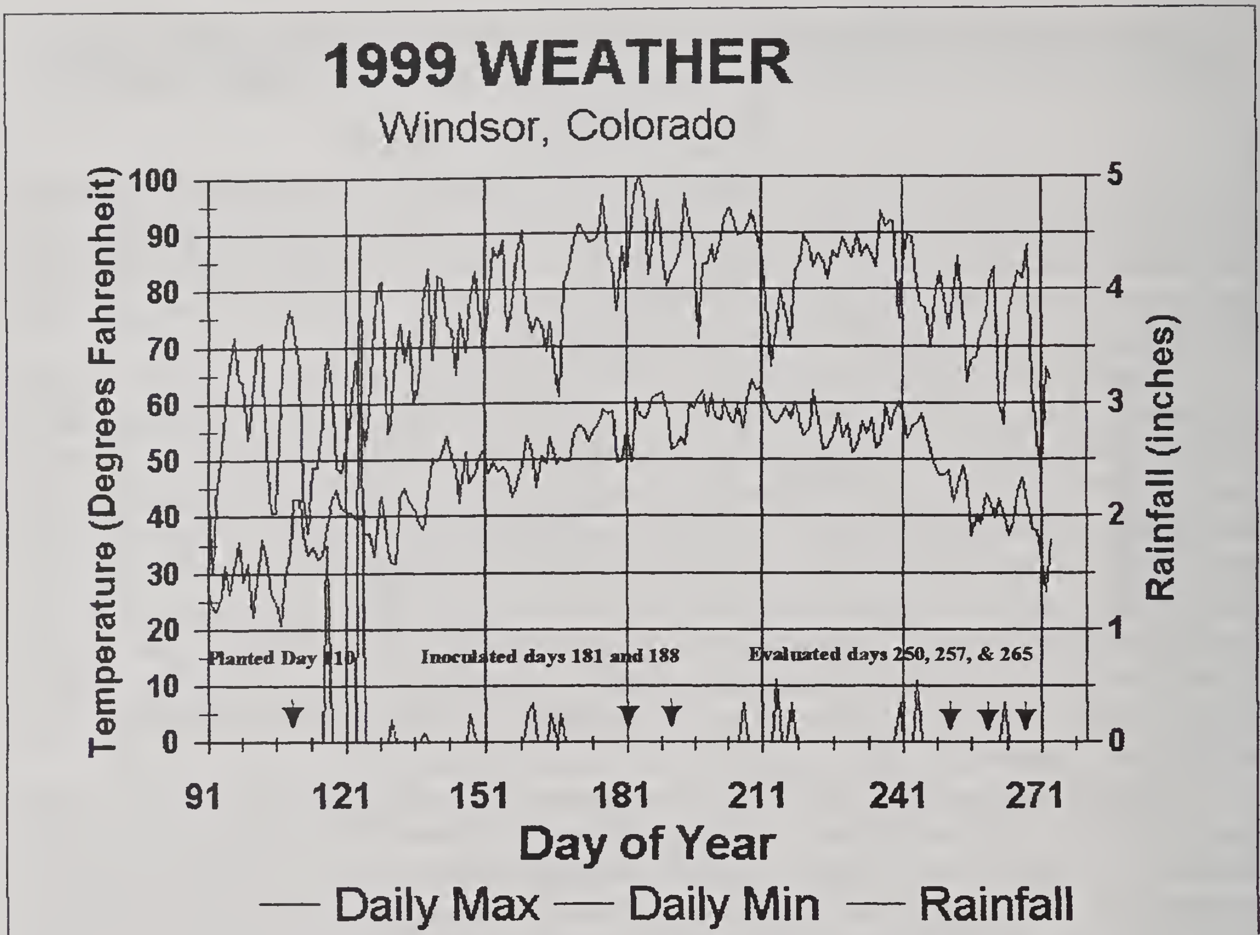


Figure 2 & Table 2. 1999 Cercospora Leaf Spot Nursery, Fort Collins, CO. The Graph above summarizes the 1999 weather data for our Cercospora Leaf Spot Nursery int 1999. The table below presents summary data of the entire nursery. The experiment mean, the mean of the susceptible check, and the mean of the resistant check are given for each of the experiments in the nursery, for each evaluation date. The highest mean rating given on September 22nd was a 9.00 and the lowest a 2.67.

	September 7th Disease Index				September 14th Disease Index				September 22nd Disease Index			
Exp.	Mean	Sus.[1]	Res.[2]	LSD	Mean	Sus.	Res.	LSD	Mean	Sus.	Res.	LSD
1A	4.2	5.0	2.8	0.97	4.7	5.2	6.5	1.08	5.3	6.5	2.8	1.1
2A[3]	4.5	4.5	2.3	1.97	5.3	6.5	2.5	1.75	5.9	7.0	3.5	1.5
3A	4.4	4.8	2.5	1.24	5.1	5.3	3.5	0.99	5.6	5.5	3.5	0.9
4A	4.7	5.8	2.7	0.81	5.3	6.3	2.5	1.10	5.5	6.7	2.8	0.8
5A	5.0	5.2	3.3	0.93	5.4	5.8	3.2	0.80	6.0	6.2	3.7	0.6
6A	4.1	4.8	2.7	0.77	4.8	5.7	3.0	0.90	5.3	6.3	3.2	0.9
7A	3.7	5.8	2.8	0.77	3.9	6.0	2.8	0.93	4.5	6.7	3.3	1.0
7A[4]	3.6	5.0	2.7	0.77	3.9	5.2	2.8	0.93	4.7	6.5	3.3	1.0
8A	3.6	5.2	2.8	0.83	3.6	5.7	2.5	0.92	4.0	6.3	2.7	1.1
9A	3.2	5.0	2.3	0.77	3.3	5.7	2.0	0.92	3.9	6.3	2.7	1.0
Mean	4.10	5.11	2.70		4.53	5.73	3.13		5.07	6.41	3.14	

[1]Cercospora Susceptible Check - SP351069-0
[2]Cercospora Resistant Check - FC 504CMS/FC 502-2//SP6322-0
[3]There were only two replications of Experiment 2A
[4]There were two separate tests in Experiment 7A

RHIZOCTONIA ROOT ROT RESISTANCE AND DEVELOPMENT OF GENETIC RESISTANCE IN SUGAR BEET - BSDF Project 440

L. Panella

This facet of the USDA-ARS Fort Collin's sugar beet breeding program has as its goals: 1) the understanding the genetics of the *Rhizoctonia solani*/sugar beet interaction in order to better facilitate development of germplasm with high levels of resistance to Rhizoctonia and other sugar beet diseases, and 2) to provide the knowledge to better manage this disease in sugar beet production areas. It is an integrated research program with greenhouse, laboratory, and field components. Genetic information developed previously in our research is used to execute additional cycles of pathogen inoculation, plant selection, and recombination among germplasms that we have in our cyclic improvement program. Germplasms in various stages of improvement are evaluated for resistance in inoculated field tests. Results of these tests form the basis of decisions about specific germplasm, i.e., retain, shelve, discard, recombine, release, etc. Germplasms likely to be useful for variety improvement are identified and released for use by other sugar beet breeders.

1999 Field Research on Rhizoctonia Root Rot of Sugar Beet.

The breeding program in Fort Collins has created annually an artificial epiphytotic through inoculation with *Rhizoctonia solani* for over thirty years to evaluate and select for resistance to root rot caused by this pathogen. We have been pleased to participate and lead this cooperative research project between the ARS, Colorado State University, and the BSDF. The project primarily involved field studies conducted on 35 acres of leased land near Windsor, CO. Randomized, complete-block designs with five replicates were used to evaluate Fort Collins ARS breeding germplasm. Rhizoctonia-resistant line FC703 and a highly susceptible check (FC901/C817) were included as internal controls, along with highly resistant FC705-1.

One-row plots, planted May 20th, were 14 feet long with 22 inches between rows and 8-10 inches within-row spacing. Inoculation with dry, ground, barley-grain inoculum of *Rhizoctonia solani* isolate R-9 was performed on July 13th; immediately after inoculation, a cultivation was performed so as to throw soil into the beet crowns. The field was sprayed twice with Betamix Progress, Upbeet, and Stinger (June 2 and 12) to control weeds. The field was thinned by hand and irrigated as necessary. Beets were harvested August 23 through 27. Each root was rated for rot on a scale of 0 to 7 (dead) as previously described. ANOVAs were performed on disease indices (DIs), percent healthy roots (classes 0 and 1 combined), and percentage of roots in classes 0 thru 3. Percentages were transformed to arcsin-square roots to normalize the data for analyses ("Z% Hlthy" and "Z% 0-3" in the accompanying tables). Both percentages and arcsins are given in the table, and LSDs are provided for comparing arcsins of your entries with those of our internal checks.

We had unusually heavy spring rainfall before planting and were able to plant to moisture. We also had just a little rain in the week after planting with warming temperatures. Therefore, stands were excellent and the 1999 Rhizoctonia epidemic started strong and progressed quickly, becoming severe by mid August. Differences in DIs among entries in all tests were highly significant ($P < 0.001$). Mean DIs across all tests for highly resistant FC705-1, resistant FC703, and the highly susceptible check were 3.3, 3.9, and 6.2, respectively. Percentages of healthy roots were 17.8, 9.5, and 0.5 for these internal controls. Percentages of roots in disease classes 0 thru 3 were 56.3, 38.0, and 4.0, respectively. The highest and lowest DIs for evaluated lines were 6.8 and 2.0, respectively.

Allotment of Fort Collins "FC" numbers (3-digit numbers)

"FC" numbers are "convenience" numbers for "seed releases" or purposes where a permanent line designation is needed — i.e. a number that does not change from generation to generation where little or no selection pressure is applied. Initially, an "FC" no. was written thus "FC 501" [now FC727], "FC 502 CMS" [now FC715CMS], etc. Sublines (from selfing) were designated thus, "FC 502/2" [now FC709-2], "FC502/3" [now FC502-3], etc. The same applies when the line is substantially changed by selection without selfing.

Below 500	Originally LeRoy Powers - now parental lines and special genetic stocks.
500's	Leaf Spot Resistant (LSR), Type-O lines & male steriles [CMS]
600's	LSR-Curly Top Resistant (CTR), type-O lines & male steriles [CMS]
700's	Rhizoctonia Resistant
800's	LSR-CTR-Rhizoctonia resistant
900's	Pollinators, LSR-CTR type

This year, I also completed a one year evaluation of most of the Rhizoctonia-resistant lines released from the USDA-ARS breeding project at Fort Collins (Table 3). This is a test from 1999 under the same conditions as the other contributor lines in this year's test.

Transforming Rhizoctonia-Resistant Populations to Germplasm with Multiple Disease Resistance

Root rot and leaf spot are two serious diseases of sugar beets caused by fungi (*Rhizoctonia solani* and *Cercospora beticola*, respectively). The diseases caused by these fungi may produce a severe reduction of yield in many sugar beet production areas. Cultural control measures are not adequate by themselves, and often no chemicals are registered for control of these diseases, or chemical control is expensive or environmentally unsafe. Increased levels of genetic resistance in sugar beet varieties are needed to minimize growers' losses from these diseases. In a hybrid crop like sugar beets, it is preferable that all of the parents contain some level of resistance to diseases prevalent in the area in which the hybrid is to be grown. Multiple disease resistance is a difficult goal in a crop improvement program, especially when working with an outcrossing species. In alternating generations of selection, some of the progress made in resistance to one disease is lost while selecting for resistance to other diseases.

One way of solving the problem of selecting for multiple disease resistance is the use of progeny testing. By testing the progeny of individual mother roots, plants with multiple disease resistance can be identified and used as parents of the next generation. The most efficient use of progeny testing is when the genotype of both parents is controlled, and the most effective way to do this is through self-pollination. In sugar beet, there is a dominant, self-fertility gene that permits self-

pollination. Used in conjunction with genetic male sterility, to insure cross pollination, a system of selfed-family progeny testing can be utilized.

This effort is based on the Rhizoctonia-resistant materials from the programs of John Gaskill and Richard Hecker, and disease resistant germplasm from other sources to produce germplasm highly resistant to Rhizoctonia solani. This base of Rhizoctonia-resistant germplasm is being combined with material from the USDA-ARS breeding programs at Salinas and Fargo, as well as with sources for higher yield and sucrose. The Salinas material has the self-fertility allele, is segregating for genetic male sterility, and also contains a broad spectrum of resistance to diseases of importance in California as well as other sugar beet production areas (including rhizomania, powdery mildew, virus yellows, and curly top virus). Fargo sources of root maggot and Cercospora leaf spot resistance are also being utilized.

A number of source populations are being developed. The germplasm, FC712(4X) has been released in 2000. This germplasm was developed in our research project that has been contributed to, in kind, by the Beet Sugar Development Foundation. This tetraploid pollinator germplasm combines excellent Rhizoctonia-root-rot resistance with a good level of Cercospora leaf spot resistance. Populations whose development was begun under the breeding program of Dr. Richard Hecker are still being evaluated and selected in the field. These germplasms and other germplasms from the Fort Collins program were field-tested in summer of 1999 for resistance to *R. solani* (Tables 3-4), *C. beticola* (Tables 5-7), and the curly top virus (Table 8). More germplasms that were selected for increased resistance to Rhizoctonia-root-rot in 1998, and tested in 1999, will be tested again in 2000; and the most promising of these will be released in the future.

There currently are four major groups of Rhizoctonia-resistant germplasms currently under development.

1. Germplasms developed in Dr. Hecker's breeding program for resistance to Rhizoctonia root rot and Cercospora leaf spot are being field tested and selected in the Rhizoctonia root rot nursery at Fort Collins (also in the Cercospora leaf spot and curly top nurseries).

2. Rhizoctonia-resistant monogerm polycross base population developed by a cross between FC708 and two Salinas germplasms, 2890 and 2859.

   A. 2890 (sp) 0790 *mm aa* x 1890 (Salinas); is seed from *aa* plants open pollinated by A- plants. 0790 = population-790 cycle 5 synthetic by S_1 progeny, M.S. mm, O-type, good combining ability, adapted to California, S^f,. 1890 = BC population to population 790 to get Rz equivalent, remains variable for M-:mm, Rz-:rzrz, etc.
   B. 2859 m (sp) = 1859, 1859R aa x A- (Salinas); Released in 1992 as C859. S^f, similar to 2890, but should have higher curly top resistance (CTR). Segregates and variable for M-:mm, Rz-:rzrz, A-:aa, predominant background is lines like C563, which is widely used in western USA as source of CTR, mm, O-type.

3. Rhizoctonia root rot resistance multigerm base population developed by a cross between FC709-2 and a Salinas germplasms, 2915.
   A. 2915 (sp) RZM 1915-#m 1913-# aa x A (Salinas); Seed harvested from aa (ms) plants open-pollinated by A- (fertile) plants. This population will segregate for A-:aa, Rz-:rzrz, s^ss^s:s^f-,

(>½ s^f), R-:rr, It will be multigerm, have moderate to good tolerance to virus yellows, curly top, bolting, Erwinia; variable for reaction to powdery mildew, production traits. Individual plants will be either As or aa. Background of population is mostly from OP, MM lines such as C46, C37.

4. Combination Rhizoctonia root rot and Cercospora leaf spot resistant multigerm pollinator population from FC907 (out of Fargo) and FC709-2.

<u>Progress in 1999</u>

1. Selections have been made in these populations and they have been crossed with other germplasm in a continuing *Rhizoctonia*-resistance breeding effort. One tetraploid multigerm pollinator [FC712 4(X)] has been released. It has excellent resistance to Rhizoctonia root rot and good Cercospora resistance. Three to five monogerm O-type lines with and without and CMS equivalents, selected in the 1996 Rhizoctonia nursery were re-tested this year and will be considered for release this summer.

2. S_1 families selected for curly top resistance from this monogerm base populations were selected in the Rhizoctonia nursery last year. This germplasm has been harvested increased in the Greenhouse at Fort Collins. This seed was planted in the mother root nursery at Fort Collins for increase and a split sample was sent to Salinas where it is being selected to see if the Holly gene for Rhizomania resistance is still segregating in the population. Rhizomania resistant plants will be intercrossed and seed planted in the Rhizoctonia nursery to be selected for resistance.

3. Individual selfed & half-sib families were harvested and progeny tested in the Rhizoctonia and curly top nursery in 1998 and Rhizoctonia nursery this year. Selections were made from the Rhizoctonia nursery and remnant seed is available for the top performers in the curly top nursery. These selections have been recombined and will be tested next year and the following year.

4. Seed, increase from Rhizoctonia-resistant selected roots of FC907 ((FC701 x FC607)BC_4), was tested in the Rhizoctonia and Cercospora nurseries next year. Selections made in a (FC709-2 x FC907)F_2 population in the Rhizoctonia were increased in the greenhouse and tested in the Rhizoctonia and curly top nurseries. This population will be re-selected in the Rhizoctonia nursery and then tested in the Rhizoctonia, Cercospora, and curly top nurseries. Half-sib family selections from this population (35 families) were made in the 1999 Cercospora nursery.

Future laboratory research will use the information gained from studying the pathogen *Rhizoctonia solani* to begin to look at the sugar beet reaction to this pathogen. Biocontrol work will resume once a new Research Plant Pathologist is on board.

Table 3. Experiment 4R, 1999. Rhizoctonia Resistance Evaluation of USDA-ARS Breeding Lines from Fort Collins CO, (Lee Panella)

ID	Seed Source	Description	DI[1]	% Hlthy[2]	% 0 - 3[3]	Z%[4] Hlthy	Z% 0 - 3[4]
		LSD[5]	0.90			14.5	18.2
	981009H	(907/709-2)F2-Sel Rhzc	5.0	8	12	13	18
	931017	Susceptible Check - (FC901/C817)	5.9	0	2	0	4
	991011		3.0	26	64	30	53
	991014		4.0	16	32	20	34
	961012HO	FC712/Mono-Hy A4	4.4	8	30	10	32
	961012HO1	FC712/Mono-Hy A4	4.9	2	14	4	19
	991002MS		5.6	2	8	4	15
	991002PF		5.7	2	8	4	13
EL 50	WC980439		4.8	8	22	13	27
EL 52	99A003	98J26-052	5.0	4	8	7	15
EL 48	97A004		5.5	4	10	7	14
FC701	931024		5.7	0	6	0	11
FC701-4	761068H		3.6	18	44	24	41
FC701-5	721056		4.7	4	18	7	22
FC701-6	801059H		3.2	20	56	23	48
FC702	681009-0		5.4	4	12	5	13
FC702-6	811055H		3.2	22	56	27	49
FC703	751080H	Resistant Check	3.8	12	42	18	40
FC705/1	831083	Highly Resistant Check	3.3	22	56	27	49
FC705	781066H		3.3	22	50	25	45
FC708	831085HO		4.4	6	30	7	30
FC709	891026H		2.5	32	80	34	66
FC709-2	921024	Fort Collins release	2.0	42	92	40	77
FC710	891033		3.6	14	54	19	50
FC710(4X)	971017	FC710 colchicine doubled	3.4	10	66	12	61
FC711	821087		4.9	2	22	4	22
FC712	881032H	Fort Collins Release	2.6	28	76	31	64
FC712(4X)	971018	FC 712 colchicine doubled	3.0	26	62	27	55
FC715	911026HO		4.3	16	32	21	33
FC716	971019		3.2	18	64	22	54
FC717	911031		4.9	4	16	7	21
FC718	911032		3.8	14	42	21	40
FC719	911037		3.1	18	66	22	58

Table 3. Experiment 4R, 1999. Rhizoctonia Resistance Evaluation of USDA-ARS Breeding Lines from Fort Collins CO, (Lee Panella)

ID	Seed Source	Description	DI[1]	% Hlthy[2]	% 0 - 3[3]	Z%[4] Hlthy	Z% 0 - 3[4]
		LSD[5]	0.90			14.5	18.2
FC720-1	961015	C718/(C718/FC708)	4.1	8	38	10	38
FC722-1	961010HO	C718/FC708	4.0	6	44	11	41
FC722CMS	961010HO1	C718/FC708	4.6	2	14	4	17
FC723	951016HO	EL44/FC708 mm	3.8	16	40	23	38
FC723CMS	951016HO1	EL44/FC708 CMS	3.9	8	36	15	37
FC724-1	961014	FC702/LSR-CTR	3.1	16	62	19	55
FC725	921008		3.3	22	62	27	52
FC726	931010		3.5	16	50	21	44
FC727	951017	Fort Collins release	4.1	10	38	16	38
FC728	921025		3.0	18	68	25	56
FC729	921019	FC712/A4, 3 cycles Rhizoc, MM	3.9	12	40	16	39
FC907-1	971020	FC607/FC701 BC_4 - 1 cycle of RhzcR sel	6.1	0	4	0	7
		Experiment Mean	**4.1**	**13**	**39**	**16**	**37**

[1]Disease Index is based on a scale of 0 (=healthy) to 7 (= plant dead).
[2]Percent of healthy roots (disease classes 0 and 1 combined).
[3]Percent of diseased roots likely to be taken for processing (disease classes 0 through 3 combined).
[4]Percentages were transformed to arcsin-square roots to normalize the data for analyzes.
[5]P=0.05

Table 4. Experiment 10R, 1999. Rhizoctonia Resistance Evaluation of USDA-ARS Breeding Lines, Fort Collins, CO; East Lansing, MI; and Fargo, ND.

Description	Seed Source	Location	DI[1]	% Hlthy[2]	% 0 - 3[3]	Z%[4] Hlthy	Z% 0 - 3[4]
		LSD[5]	0.87			14.9	18.9
EL 51	WC980435L	East Lansing	3.0	28	68	31	56
99J02-00		East Lansing	5.8	0	6	0	11
99J19-00		East Lansing	5.0	6	24	9	23
99J20-00		East Lansing	4.9	2	18	4	20
99J25-024		East Lansing	5.2	4	14	5	19
98J26-2		East Lansing	4.8	4	10	7	14
98J26-3		East Lansing	4.5	8	26	13	27
98J26-7		East Lansing	4.7	6	14	11	19
98J25-38-5		East Lansing	4.7	8	16	13	23
98J25-01-3		East Lansing	4.4	8	20	13	24
F1001	97N0050	Fargo	5.4	6	12	7	13
F1002	96N0021	Fargo	4.6	4	20	5	22
F1004	96N0022	Fargo	6.0	0	6	0	9
F1005	98N0058	Fargo	6.2	0	2	0	4
F1006	96N0023	Fargo	4.1	6	36	7	39
FC712(4X)	971017	Fort Collins	3.6	6	62	7	55
FC710(4X)	971018	Fort Collins	3.1	22	62	27	52
FC712	881032H	Fort Collins	2.8	24	64	29	53
FC709-2	921024	Fort Collins	2.5	28	84	32	67
FC727	951017	Fort Collins	3.1	20	58	24	50
FC724	961014	Fort Collins	2.6	36	70	37	58
FC720	961015	Fort Collins	3.3	20	58	23	50
FC710	891033	Fort Collins	2.8	26	72	30	59
Susceptible Check	931017	FC901/C817	6.0	2	4	4	7
Highly Resistant Check	831083	FC705/1	2.8	28	70	25	60
Resistant Check	751080H	FC703	3.7	12	42	15	40
Experiment Mean			4.2	12	36	14	34

[1]Disease Index is based on a scale of 0 (=healthy) to 7 (= plant dead).
[2]Percent of healthy roots (disease classes 0 and 1 combined).
[3]Percent of diseased roots likely to be taken for processing (disease classes 0 through 3 combined).
[4]Percentages were transformed to arcsin-square roots to normalize the data for analyzes.
[5]P=0.05

CERCOSPORA LEAF SPOT RESEARCH AND BREEDING FOR CERCOSPORA AND CURLY TOP RESISTANCE - (BSDF Project 441)

L. Panella

This element of the breeding program at Fort Collins is devoted to the development of germplasm with resistance to more than one sugar beet disease and improved agronomic characteristics. It is built on germplasm developed at Fort Collins over the last fifty years for combined resistance to Cercospora leaf spot and the curly top virus. This is an integrated breeding program with greenhouse and laboratory studies, and a field program based on testing in an artificial epiphytotic created in the unique Fort Collins environment. It involves close collaboration with the other USDA-ARS sugar beet programs in the U.S. and sugar beet seed industry customers. The major goals of this program are: 1) the development of sugar beet germplasm with resistance to more than one disease and excellent agronomic characteristics; 2) the improvement of breeding techniques, traditional and molecular, to develop this germplasm; and 3) an increased understanding of the sugar beet/pathogen interactions to improve management practices of these diseases in sugar beet production areas. Genetic information developed during this research will be used to execute additional cycles of pathogen inoculation, plant selection, and recombination among germplasms that we have in our leaf spot improvement program. Results of these tests will be the basis of decisions about specific germplasm, i.e., retain, discard, recombine, release, etc. Germplasms likely to be useful for variety improvement will be identified and released for use by other sugar beet breeders.

Increased resistance to *Cercospora* continues to be an extremely important goal. If the level of resistance available in most Cercospora-resistant experimental lines were present in commercial hybrids (along with good sugar and seed yield), the need for fungicides would be greatly reduced. That continued improvement in genetic resistance to this serious pathogen is still needed is evident by the occurrence of *Cercospora* strains that are resistant or increasingly tolerant to our most potent fungicides. Additionally, some of these fungicides may be removed from the market because of their perceived or real threat to the environment. In many areas where Cercospora leaf spot is a problem, the curly top virus also causes significant losses. And, there are some growing areas in which combined resistance to Cercospora leaf spot, Rhizomania, curly top, Rhizoctonia root rot, and other diseases are desirable. Germplasm is needed with combined resistance to these diseases, along with good combining ability for yield components.

1999 Field Research on Cercospora Leaf Spot of Sugar Beet

The breeding program in Fort Collins has created an artificial epiphytotic through inoculation with *Cercospora beticola* annually for over forty years to evaluate and select for resistance to leaf spot caused by this pathogen. We have been pleased to participate and lead this cooperative research project between the ARS, Colorado State University, and the BSDF. The project primarily involved field studies conducted on 35 acres of leased land near Windsor, CO.

Randomized complete-block designs, with three replications were used to evaluate commercial and experimental entries. Internal controls included a highly susceptible synthetic and a resistant check (FC 504/502-2//SP6322-0). The nursery was planted on April 29th. Fertilization was 75% of the soil test recommendation to minimize leaf growth, which can interfere with visual evaluations. Differences among lines were highly significant in all tests at each of three evaluation

dates. Two-row plots were 12 feet long, with 22-inch row spacing and an 8 - to 10-inch within-row plant spacing. The trial was planted on April 20th in Windsor, CO. Inoculation was performed on June 30th and again on July 7th. Evaluations were made on September 7th, 14th, and 22nd, with the peak of the epidemic occurring on or about the last date. The field was sprayed twice with Betamix Progress, Upbeet, and Stinger (May 14th and 24th) to control weeds. The field was thinned by hand and irrigated as necessary.

We had good spring rain in 1999 and emergence was excellent and we got off to an early start. The 1999 leaf spot epidemic started strong and progressed rather slowly, but eventually became more severe by late August. We had a period between of about one month right after inoculation, in which we had relatively high evening temperatures (Figure 2), which helped disease development, however by September or evening temperatures had dropped. At our third evaluation, means of the resistant and susceptible internal controls were 3.1 and 6.4 (scale of 0-10), respectively, across the nursery. In 1998 (September 8), these means were 3.2 and 5.3, respectively. Means of contributor lines on September 22 ranged from 2.7 to 9.0, compared with 2.5 to 8.0 in the milder epidemic of 1998.

Cercospora/Curly Top-Resistant Populations with Resistance to Multiple Sugar Beet Diseases and Superior Agronomic Characteristics

Advanced breeding lines or Cercospora-resistant germplasms from Fargo (5), Salinas (16), East Lansing (10), and Fort Collins (9) were evaluated in Experiment 7A at the ARS leaf spot nursery at Ft. Collins (Table 5). A blend of resistant and susceptible commercial hybrids was also evaluated by Larry Campbell - USDA-ARS at Fargo, ND. An additional 26 Fort Collins advanced breeding lines or released germplasms were evaluated for Cercospora leaf spot resistance in Experiment 9A (Table 6). Progeny families from two USDA-ARS Fort Collins populations and one USDA-ARS East Lansing mapping population were evaluated in experiment 10A (Table 7). Breeding lines and family progeny were also tested at the BSDF Nursery in Kimberly, ID (Table 8).

Cercospora Leaf Spot/Curly Top Resistant (LSR/CTR) Breeding Populations Currently under Development.

1. Cercospora leaf spot and curly top resistant monogerm base population from a polycross of FC607 and FC604 with two Salinas germplasms 2859 and 2890.
   C. 2890 (sp) = 0790 *mm aa* x 1890 (Salinas); is seed from *aa* plants open pollinated by A-plants. 0790 = population-790 cycle 5 synthetic by S_1 progeny, *aa*, mm, O-type, good combining ability, adapted to California, S^f. 1890 = BC population to population 790 to get Rz equivalent, remains variable for M-:mm, Rz-:rzrz, etc.
   D. 2859 m (sp) = 1859, 1859R aa x A- (Salinas); Released in 1992 as C859. S^f, similar to 2890, but should have higher curly top resistance. Segregates and variable for M-:mm, Rz-:rzrz, A-:aa, predominant background is lines like C563.

2. Cercospora leaf spot and curly top resistant multigerm base population from a polycross of FC902 with two Salinas germplasms 278 and 4918.
   A. 278 (Iso 83) = RZM R078; R278 is Rz (segregates Rz--:rzrz) version of C46. It should be S^sS^s, MM.

B. 4918 (sp) = RZM 3918aa X A-, 142 aa plants; This is an increase of released material C918. It should be Multigerm, over 75% S^f and segregating for A-, R-, Rz-, VY, CT, Erw, & PM.

3. Cercospora leaf spot and curly top resistant multigerm, self-incompatible base population from a polycross of FC607 x [SR87, MonoHy A4, MonoHy T6, & MonoHy T7]

4. Seed from FC709-2 x FC907 was sent to Larry Campbell at Fargo to cross to Sugar beet root maggot resistant germplasm to develop a population that will produce pollinators with resistance to Rhizoctonia, Cercospora, and Root maggot.

5. Two tetraploid pollinators (FC6064X and FC6074X) were crossed to a high sucrose tetraploid population in order to produce a tetraploid Cercospora resistant pollinator population with better combining ability.

Progress in 1999

Advanced breeding lines of *Cercospora* resistant germplasms were evaluated in the ARS leaf spot nursery at Ft. Collins. These lines are part of the resistant germplasm development effort in which a new germplasm should be released from the "pipeline" every two to four years. The above populations currently are in different stages of development.

1. Selections were made 1998 among half-sib progeny rows of the monogerm population. Families were selected based on leaf spot resistance, curly top resistance, and combined leaf spot and curly top resistance. They were increased and will be tested in the Cercospora nursery and curly top nursery in 2000. They have been also planted in Salinas to select for the single gene source of Rhizomania resistance. Selected roots are being recombined and the resulting population(s), tested, O-type screened, released, or reselected.

2. Plants (F_2) from the CTR/LSR multigerm cross (2) were planted in the breeding nursery last summer and *aa* females crossed to the (FC709-2 x FC907)F_2 roots selected in the Rhizoctonia nursery. This seed has been bulk increase and the resulting population will be a source of curly top resistant multigerm pollinators with leaf spot and Rhizomania resistance.

3. Plants (F_2) from the Fort Collins and Fargo joint project (3) were grown in the breeding nursery and these roots were planted in Masonville selfed, taking advantage of the 'pseudo self-fertility' that occurs in this environment. This selfed seed was progeny tested in 1999. The most resistant families will be recombined and selected for yield factors . This population will be a source of highly leaf spot resistant multigerm pollinators with curly top resistance and good combining ability for agronomic traits.

4. Plants (F_1) from this multigerm cross (4) have been grown in the greenhouse and selfed to produce F_2 seed.

5. Bulked F_2 seed was planted in the Rhizoctonia and curly top nursery and half-sib families in the Cercospora nursery. The F_1 has been bulk increased and F_2 seed will be planted in the 2000

Cercospora nursery to select for sucrose and resistance to Cercospora leaf spot.

The seed from the above mentioned populations will be developed and advanced after testing. Development of a resistant germplasm line generally takes 7 years. A longer time may be necessary to incorporate multiple disease resistances. In an established program, a "pipeline" of lines in various stages of development and evaluation is the norm. Hence, the release of new germplasm usually occurs every 2 to 4 years.

Genetic information developed in this research will be used to execute additional cycles of pathogen inoculation, plant selection, and recombination among germplasms that we have in our leaf spot improvement program. Results of these tests will be the basis of decisions about specific germplasm, i.e., retain, discard, recombine, release, etc. Germplasms likely to be useful for variety improvement are identified and released for use by other sugar beet breeders. Breeding techniques are compared in developing these germplasm and information on the efficacy and efficiency of these techniques generated.

Table 5. Experiment 7A, 1999. Leaf Spot Evaluation of USDA-ARS Fort Collins, Salinas, East Lansing, and Fargo breeding lines.

Entry	Identification		Disease Index[1]		
			September 7th	September 14th	September 22nd
		$LSD_{0.05}$	0.77	0.93	1.02
LSS [2] (931002)			5.0	5.2	6.5
LSR [3] (821051H2)			2.7	2.8	3.3
Trial Mean			3.6	3.9	4.7
99J02-00	99J02-00	East Lansing - JS	2.7	2.8	3.0
98J02x05	98J02x05	East Lansing - JS	2.8	2.8	3.3
99J25-023	99J25-023	East Lansing - JS	2.7	2.8	3.5
99J19-00	99J19-00	East Lansing - JS	2.8	3.0	3.7
EL 51	WC9800435L	East Lansing - JS	2.7	3.0	3.8
99J31-00	99J31-00	East Lansing - JS	3.0	3.3	3.8
WC980437	WC980437	East Lansing - JS	3.0	3.7	4.0
99J33-00	99J33-00	East Lansing - JS	4.0	4.0	4.7
98J28-02	98J28-02	East Lansing - JS	3.8	4.2	4.8
EL 38	WC980433	East Lansing - JS	4.3	4.5	5.7
96N0012	Low Sodium	Fargo - LC	2.8	3.3	3.7
96N0011	Low Potassium	Fargo - LC	3.3	3.3	4.3
97N0132	F1015	Fargo - LC	4.2	4.7	5.5
96N0009	Low amino-N	Fargo - LC	3.8	4.2	5.8
98N0057	F1016	Fargo - LC	3.8	4.3	6.0
B-5931	Commercial	Fargo - LC	3.2	3.2	3.5
75 (3712)/25 (5931)	Commercial	Fargo - LC	3.8	4.2	4.8
25 (3712)/75 (5931)	Commercial	Fargo - LC	3.7	3.8	5.0
50 (3712)/50 (5931)	Commercial	Fargo - LC	3.8	4.0	5.2
B-3712	Commercial	Fargo - LC	5.3	5.8	6.0
97-SP22-0	Inc. SP7622-0 (LSR ck) - Iso 86	Salinas - RL	3.3	3.7	4.2
Monodono	(resistant check) - HM	Salinas - RL	3.5	3.7	4.3
EL-02	Rzm EL (Rz x sm. root) - Iso 53	Salinas - RL	3.8	4.2	4.7
Ippolita	(resistant check) - HM	Salinas - RL	3.5	3.7	4.7
CR811	Rzm 711, CR09/10 - Iso 86	Salinas - RL	3.5	3.7	4.7

Table 5. Experiment 7A, 1999. Leaf Spot Evaluation of USDA-ARS Fort Collins, Salinas, East Lansing, and Fargo breeding lines.

Entry	Identification		Disease Index[1]		
			September 7th	September 14th	September 22nd
		$LSD_{0.05}$	0.77	0.93	1.02
LSS[2] (931002)			5.0	5.2	6.5
LSR[3] (821051H2)			2.7	2.8	3.3
Trial Mean			3.6	3.9	4.7
US H11	LSS check - HH	Salinas - RL	3.8	3.8	4.8
Y869	Rzm Y769, C69 - Iso 9	Salinas - RL	3.7	4.3	5.0
EL-04	Rzm EL (Rz x sm. root) - Iso 54	Salinas - RL	3.7	4.2	5.0
CR812	Rzm 712 - Iso 87	Salinas - RL	3.8	4.0	5.3
R827	Rzm R727A, B - Iso 12	Salinas - RL	4.5	5.3	5.3
CR813	Rzm 713 - Iso 88	Salinas - RL	3.5	4.2	5.5
Y875	Rzm 775 - Iso 11	Salinas - RL	4.3	5.0	5.5
R726	Rzm-ER R526, C26 - Iso 66	Salinas - RL	3.5	4.5	5.8
8932M(CTR)	7932 CT,...aaxA - Sp 12	Salinas - RL	3.8	4.5	6.3
Rifle	Commercial Check - SS	Salinas - RL	5.5	6.2	6.5
B4430R	L4430 (LSS ck)	Salinas - RL	7.3	7.0	7.7
911026HO	FC715	Fort Collins	3.0	2.8	3.3
831085HO	FC708	Fort Collins	3.0	3.0	3.5
97A050	FC607	Fort Collins	3.0	3.0	3.7
921021	FC703-5	Fort Collins	3.0	3.5	3.8
921024	FC709-2	Fort Collins	3.2	3.5	4.0
921025	FC728	Fort Collins	3.5	3.5	4.0
921022	FC702-7	Fort Collins	2.8	3.2	4.3
951017	FC727	Fort Collins	3.3	4.0	4.7
911031	FC717	Fort Collins	3.5	4.2	4.8

[1]Disease Index is based on a scale of 0 (=healthy) to 10 (=dead).
[2]The Leafspot Susceptible Check is SP351069-0.
[3]The Leafspot Resistant Check is ((FC504CMS x FC502/2) x SP6322-0).

Table 6. Experiment 9A, 1999. Leaf Spot Evaluation of USDA-ARS Fort Collins breeding lines.

Entry	Identification		Disease Index[1] September 7th	September 14th	September 22nd
		$LSD_{0.05}$	**0.77**	**0.92**	**1.02**
LSS[2] (931002)			**5.0**	**5.7**	**6.3**
LSR[3] (821051H2)			**2.3**	**2.0**	**2.7**
Trial Mean			**3.2**	**3.3**	**3.9**
911026HO	FC715	released	2.3	2.3	2.7
99A003	EL 52	released	2.3	2.5	2.8
921024	FC709-2	released	2.5	2.7	2.8
961013HO	FC506	released	2.8	3.0	3.0
96A009	EL 50	released	2.7	2.3	3.0
831085HO	FC708	released	3.0	2.5	3.0
99A001	892016H2	FC607 OT/Beta 2007 (2X)	3.0	2.7	3.3
921022	FC702-7	+ 7 cycles Rhizoc	2.8	2.8	3.3
97A050	FC607 released		2.8	2.5	3.3
98A152	892010H2	FC607 OT/ Hilleshög 8277	3.0	2.7	3.3
971017	FC710 (4X)		2.8	3.0	3.3
971018	FC712 (4X)		2.5	2.8	3.5
921021	FC703-5	released	3.0	3.0	3.7
861039	FC712	released	3.5	3.2	3.7
961010HO1	FC722CMS	C718/FC708 CMS	3.2	3.3	3.7
961010HO	FC722-1	C718/FC708	3.3	3.0	3.7
951017	FC727	released	3.5	3.3	3.7
961015	FC720-1	C718//(C718/FC708)	3.0	3.0	3.7
961011HO1	FC607/FC708CMS		3.3	3.5	3.8
991014	Rhizoctonia Resistant Multigerm pop (2915/FC709-2)		3.2	3.2	3.8
951014	(2890aa & 2859aa) x FC708		3.3	3.5	3.8
99A006	SR 94	released	3.3	3.5	4.0
971020	FC907-1	FC607/FC701 BC4	3.5	3.5	4.2

Table 6. Experiment 9A, 1999. Leaf Spot Evaluation of USDA-ARS Fort Collins breeding lines.

Entry	Identification		Disease Index[1]		
			September 7th	September 14th	September 22nd
		$LSD_{0.05}$	0.77	0.92	1.02
LSS[2] (931002)			**5.0**	**5.7**	**6.3**
LSR[3] (821051H2)			**2.3**	**2.0**	**2.7**
Trial Mean			**3.2**	**3.3**	**3.9**
911031	FC717 released		3.3	3.5	4.2
921025	FC728 released		3.3	3.5	4.3
99A002	892012H2		3.7	4.5	4.7
961012HO	FC712/MonoHy A4		3.7	4.3	4.8
961011HO	FC607/FC708		3.8	4.2	5.0
961012HO1	FC712/MonoHy A4 - CMS equivalent		4.0	4.3	5.0
951016HO1	FC723CMS EL44/FC708 CMS		3.5	4.0	5.2
Red Beet Filler			4.2	5.2	5.7
951016HO	FC723 EL44/FC708 mm		4.3	4.5	5.8

[1]Disease Index is based on a scale of 0 (=healthy) to 10 (=dead).
[2]The Leafspot Susceptible Check is SP351069-0.
[3]The Leafspot Resistant Check is ((FC504CMS x FC502/2) x SP6322-0).

Table 7. Experiment 10A, 1999. Leaf Spot Evaluation of USDA-ARS Fort Collins ½ sib and selfed Progeny .

Entry	Identification	Disease Index[1]		
		September 7th	September 14th	September 22nd
LSS [2] (931002)		**5.0**	**5.7**	**5.0**
LSR [3] (821051H2)		**2.3**	**2.0**	**2.0**
Trial Mean		**2.7**	**3.2**	**3.8**
991004 -37	961023⊗ = (FC907 x FC709-2)F2-Rhzc blk	2.00	2.50	2.25
991004 -25	961023⊗ = (FC907 x FC709-2)F2-Rhzc blk	2.00	2.00	2.50
991004 -8	961023⊗ = (FC907 x FC709-2)F2-Rhzc blk	2.25	2.75	2.75
991004 -44	961023⊗ = (FC907 x FC709-2)F2-Rhzc blk	2.25	2.50	2.75
991004 -45	961023⊗ = (FC907 x FC709-2)F2-Rhzc blk	2.50	3.00	3.00
991004 -35	961023⊗ = (FC907 x FC709-2)F2-Rhzc blk	2.00	2.75	3.00
991004 -13	961023⊗ = (FC907 x FC709-2)F2-Rhzc blk	2.25	2.25	3.00
991004 -30	961023⊗ = (FC907 x FC709-2)F2-Rhzc blk	2.25	2.25	3.00
991004 -17	961023⊗ = (FC907 x FC709-2)F2-Rhzc blk	2.00	2.50	3.00
991004 -36	961023⊗ = (FC907 x FC709-2)F2-Rhzc blk	3.00	3.00	3.00
991004 -12	961023⊗ = (FC907 x FC709-2)F2-Rhzc blk	2.50	3.00	3.25
991004 -20	961023⊗ = (FC907 x FC709-2)F2-Rhzc blk	2.25	3.00	3.25
991004 -52	961023⊗ = (FC907 x FC709-2)F2-Rhzc blk	2.50	3.00	3.25
991004 -7	961023⊗ = (FC907 x FC709-2)F2-Rhzc blk	3.00	3.00	3.50
991004 -48	961023⊗ = (FC907 x FC709-2)F2-Rhzc blk	2.25	3.00	3.50
991004 -3	961023⊗ = (FC907 x FC709-2)F2-Rhzc blk	2.50	3.00	3.50
991004 -38	961023⊗ = (FC907 x FC709-2)F2-Rhzc blk	2.75	3.00	3.50
991004 -1	961023⊗ = (FC907 x FC709-2)F2-Rhzc blk	2.25	3.00	3.75
991004 -15	961023⊗ = (FC907 x FC709-2)F2-Rhzc blk	3.00	3.50	4.00
991004 -18	961023⊗ = (FC907 x FC709-2)F2-Rhzc blk	3.00	3.50	4.00
991004 -4	961023⊗ = (FC907 x FC709-2)F2-Rhzc blk	3.00	3.50	4.00
991004 -23	961023⊗ = (FC907 x FC709-2)F2-Rhzc blk	3.25	3.75	4.00
991004 -42	961023⊗ = (FC907 x FC709-2)F2-Rhzc blk	3.00	3.00	4.00
991004 -22	961023⊗ = (FC907 x FC709-2)F2-Rhzc blk	2.75	3.50	4.25

Table 7. Experiment 10A, 1999. Leaf Spot Evaluation of USDA-ARS Fort Collins ½ sib and selfed Progeny .

Entry	Identification	Disease Index[1] September 7th	September 14th	September 22nd
LSS [2] (931002)		**5.0**	**5.7**	**5.0**
LSR [3] (821051H2)		**2.3**	**2.0**	**2.0**
Trial Mean		**2.7**	**3.2**	**3.8**
991004 -46	961023⊗ = (FC907 x FC709-2)F2-Rhzc blk	3.00	3.00	4.25
991004 -53	961023⊗ = (FC907 x FC709-2)F2-Rhzc blk	2.75	3.75	4.25
991004 -26	961023⊗ = (FC907 x FC709-2)F2-Rhzc blk	3.00	3.50	4.50
991004 -6	961023⊗ = (FC907 x FC709-2)F2-Rhzc blk	3.00	5.00	4.50
991004 -31	961023⊗ = (FC907 x FC709-2)F2-Rhzc blk	3.50	4.50	4.75
991004 -27	961023⊗ = (FC907 x FC709-2)F2-Rhzc blk	3.00	3.50	4.75
991004 -39	961023⊗ = (FC907 x FC709-2)F2-Rhzc blk	3.00	3.50	5.00
991004 -29	961023⊗ = (FC907 x FC709-2)F2-Rhzc blk	3.50	4.50	5.25
991004H	961023⊗ = (FC907 x FC709-2)F2-Rhzc blk [15 plants]	3.00	3.00	3.25
981028 -11	(FC607 x (MonoHy-T6, -A7, -A4, & SR87) - blk(Ss?)F2 - blk(Ss?)F3 - Sx	2.50	2.50	2.50
981028 -36	(FC607 x (MonoHy-T6, -A7, -A4, & SR87) - blk(Ss?)F2 - blk(Ss?)F3 - Sx	2.50	2.25	2.75
981028 -23	(FC607 x (MonoHy-T6, -A7, -A4, & SR87) - blk(Ss?)F2 - blk(Ss?)F3 - Sx	2.75	2.75	2.75
981028 -21	(FC607 x (MonoHy-T6, -A7, -A4, & SR87) - blk(Ss?)F2 - blk(Ss?)F3 - Sx	3.00	2.75	3.00
981028 -15	(FC607 x (MonoHy-T6, -A7, -A4, & SR87) - blk(Ss?)F2 - blk(Ss?)F3 - Sx	2.25	2.25	3.00
981028 -67	(FC607 x (MonoHy-T6, -A7, -A4, & SR87) - blk(Ss?)F2 - blk(Ss?)F3 - Sx	2.25	2.75	3.00
981028 -20	(FC607 x (MonoHy-T6, -A7, -A4, & SR87) - blk(Ss?)F2 - blk(Ss?)F3 - Sx	2.50	3.00	3.00
981028 -3	(FC607 x (MonoHy-T6, -A7, -A4, & SR87) - blk(Ss?)F2 - blk(Ss?)F3 - Sx	2.50	2.75	3.25
981028 -9	(FC607 x (MonoHy-T6, -A7, -A4, & SR87) - blk(Ss?)F2 - blk(Ss?)F3 - Sx	2.75	3.00	3.25
981028 -14	(FC607 x (MonoHy-T6, -A7, -A4, & SR87) - blk(Ss?)F2 - blk(Ss?)F3 - Sx	3.00	2.50	3.25
981028 -69	(FC607 x (MonoHy-T6, -A7, -A4, & SR87) - blk(Ss?)F2 - blk(Ss?)F3 - Sx	2.25	2.25	3.25
981028 -24	(FC607 x (MonoHy-T6, -A7, -A4, & SR87) - blk(Ss?)F2 - blk(Ss?)F3 - Sx	2.25	2.25	3.25
981028 -28	(FC607 x (MonoHy-T6, -A7, -A4, & SR87) - blk(Ss?)F2 - blk(Ss?)F3 - Sx	2.75	3.00	3.25
981028 -25	(FC607 x (MonoHy-T6, -A7, -A4, & SR87) - blk(Ss?)F2 - blk(Ss?)F3 - Sx	2.25	2.75	3.25
981028 -77	(FC607 x (MonoHy-T6, -A7, -A4, & SR87) - blk(Ss?)F2 - blk(Ss?)F3 - Sx	2.75	2.75	3.50

Table 7. Experiment 10A, 1999. Leaf Spot Evaluation of USDA-ARS Fort Collins ½ sib and selfed Progeny .

Entry	Identification	Disease Index[1] September 7th	Disease Index[1] September 14th	Disease Index[1] September 22nd
LSS[2] (931002)		**5.0**	**5.7**	**5.0**
LSR[3] (821051H2)		**2.3**	**2.0**	**2.0**
Trial Mean		**2.7**	**3.2**	**3.8**
981028 -85	(FC607 x (MonoHy-T6, -A7, -A4, & SR87) - blk(Ss?)F2 - blk(Ss?)F3 - Sx	2.25	2.50	3.50
981028 -66	(FC607 x (MonoHy-T6, -A7, -A4, & SR87) - blk(Ss?)F2 - blk(Ss?)F3 - Sx	2.50	3.25	3.50
981028 -50	(FC607 x (MonoHy-T6, -A7, -A4, & SR87) - blk(Ss?)F2 - blk(Ss?)F3 - Sx	2.75	3.00	3.50
981028 -30	(FC607 x (MonoHy-T6, -A7, -A4, & SR87) - blk(Ss?)F2 - blk(Ss?)F3 - Sx	2.75	3.25	3.50
981028 -19	(FC607 x (MonoHy-T6, -A7, -A4, & SR87) - blk(Ss?)F2 - blk(Ss?)F3 - Sx	2.75	2.75	3.50
981028 -49	(FC607 x (MonoHy-T6, -A7, -A4, & SR87) - blk(Ss?)F2 - blk(Ss?)F3 - Sx	3.00	3.25	3.50
981028 -59	(FC607 x (MonoHy-T6, -A7, -A4, & SR87) - blk(Ss?)F2 - blk(Ss?)F3 - Sx	3.00	3.00	3.50
981028 -61	(FC607 x (MonoHy-T6, -A7, -A4, & SR87) - blk(Ss?)F2 - blk(Ss?)F3 - Sx	2.50	3.00	3.50
981028 -71	(FC607 x (MonoHy-T6, -A7, -A4, & SR87) - blk(Ss?)F2 - blk(Ss?)F3 - Sx	2.50	3.00	3.50
981028 -57	(FC607 x (MonoHy-T6, -A7, -A4, & SR87) - blk(Ss?)F2 - blk(Ss?)F3 - Sx	2.75	3.25	3.50
981028 -53	(FC607 x (MonoHy-T6, -A7, -A4, & SR87) - blk(Ss?)F2 - blk(Ss?)F3 - Sx	2.75	3.25	3.75
981028 -7	(FC607 x (MonoHy-T6, -A7, -A4, & SR87) - blk(Ss?)F2 - blk(Ss?)F3 - Sx	2.25	2.50	3.75
981028 -51	(FC607 x (MonoHy-T6, -A7, -A4, & SR87) - blk(Ss?)F2 - blk(Ss?)F3 - Sx	2.75	3.00	3.75
981028 -2	(FC607 x (MonoHy-T6, -A7, -A4, & SR87) - blk(Ss?)F2 - blk(Ss?)F3 - Sx	2.75	3.25	3.75
981028 -1	(FC607 x (MonoHy-T6, -A7, -A4, & SR87) - blk(Ss?)F2 - blk(Ss?)F3 - Sx	2.35	3.00	3.75
981028 -55	(FC607 x (MonoHy-T6, -A7, -A4, & SR87) - blk(Ss?)F2 - blk(Ss?)F3 - Sx	2.75	3.25	4.00
981028 -75	(FC607 x (MonoHy-T6, -A7, -A4, & SR87) - blk(Ss?)F2 - blk(Ss?)F3 - Sx	2.75	3.25	4.00
981028 -5	(FC607 x (MonoHy-T6, -A7, -A4, & SR87) - blk(Ss?)F2 - blk(Ss?)F3 - Sx	3.00	3.75	4.00
981028 -12	(FC607 x (MonoHy-T6, -A7, -A4, & SR87) - blk(Ss?)F2 - blk(Ss?)F3 - Sx	3.00	3.75	4.00
981028 -13	(FC607 x (MonoHy-T6, -A7, -A4, & SR87) - blk(Ss?)F2 - blk(Ss?)F3 - Sx	3.50	4.00	4.50
981028 -78	(FC607 x (MonoHy-T6, -A7, -A4, & SR87) - blk(Ss?)F2 - blk(Ss?)F3 - Sx	3.00	4.25	4.50
981028 -84	(FC607 x (MonoHy-T6, -A7, -A4, & SR87) - blk(Ss?)F2 - blk(Ss?)F3 - Sx	3.00	4.00	6.00
99EL 01	Mapping Population for M. McGrath - USDA-ARS, E. Lansing	3.00	3.75	4.25
99EL 02	Mapping Population for M. McGrath - USDA-ARS, E. Lansing	3.50	4.50	5.25

Table 7. Experiment 10A, 1999. Leaf Spot Evaluation of USDA-ARS Fort Collins ½ sib and selfed Progeny .

Entry	Identification	Disease Index[1]		
		September 7th	September 14th	September 22nd
LSS [2] (931002)		**5.0**	**5.7**	**5.0**
LSR [3] (821051H2)		**2.3**	**2.0**	**2.0**
Trial Mean		**2.7**	**3.2**	**3.8**
99EL 04	Mapping Population for M. McGrath - USDA-ARS, E. Lansing	2.75	3.25	4.50
99EL 05	Mapping Population for M. McGrath - USDA-ARS, E. Lansing	3.00	4.00	4.25
99EL 07	Mapping Population for M. McGrath - USDA-ARS, E. Lansing	3.00	3.75	5.00
99EL 08	Mapping Population for M. McGrath - USDA-ARS, E. Lansing	3.00	3.25	4.00
99EL 09	Mapping Population for M. McGrath - USDA-ARS, E. Lansing	2.25	2.25	3.00
99EL 10	Mapping Population for M. McGrath - USDA-ARS, E. Lansing	3.25	4.25	4.50
99EL 11	Mapping Population for M. McGrath - USDA-ARS, E. Lansing	3.50	4.25	5.75
99EL 12	Mapping Population for M. McGrath - USDA-ARS, E. Lansing	3.00	4.00	5.00
99EL 15	**6869**	3.25	4.25	5.50

[1]Disease Index is based on a scale of 0 (=healthy) to 10 (=dead).
[2]The Leafspot Susceptible Check is SP351069-0.
[3]The Leafspot Resistant Check is ((FC504CMS x FC502/2) x SP6322-0).

Table 8. 1999 Curly Top Nursery in Kimberly Idaho.

Seed Source	Description	Disease Index[1] 08/31/98	Disease Index[1] 09/22/98
911032	**FC718 -- Susceptible Check**	**5.0**	**6.0**
94A068	**Beta G6040 -- Resistant Check**	**2.3**	**3.7**
98A101		3.0	4.7
98A102		3.7	5.3
98A103		3.0	5.0
98A104		3.3	5.0
98A105		4.7	6.3
98A106		4.7	6.0
98A107		4.7	5.7
98A108		4.3	5.3
98A109		3.0	5.7
98A110		3.0	4.7
98A111		3.7	4.7
98A112		3.3	4.7
98A113		4.3	6.0
98A114		4.7	5.7
98A115		3.7	5.0
98A116		3.3	5.3
98A117		3.0	5.0
98A118		3.0	5.3
98A119		4.0	5.3
98A120		5.0	6.3
98A121		5.0	6.0
98A122		5.0	7.0
98A123		4.3	6.0
98A124		5.3	6.0
98A125		4.0	5.0
98A126		4.7	5.7
98A127		3.7	4.7
98A128		3.3	4.7
98A129		4.0	5.7
98A130		5.3	6.3
98A131		6.3	7.7
98A132		4.3	6.3
98A133		3.7	5.7
98A134		3.7	4.7
98A135		3.7	4.7

Table 8. 1999 Curly Top Nursery in Kimberly Idaho.

Seed Source	Description		Disease Index[1] 08/31/98	09/22/98
911032	**FC718 -- Susceptible Check**		**5.0**	**6.0**
94A068	**Beta G6040 -- Resistant Check**		**2.3**	**3.7**
98A136			3.3	4.7
98A137			5.0	6.0
98A138			4.0	5.3
98A139			4.3	5.7
98A140			4.3	5.7
98A141			4.7	5.7
98A142			5.0	5.7
98A143			4.0	4.7
98A057			3.3	5.0
98A096			3.7	5.0
98A077			3.7	5.3
971017	FC710 (4X)		3.7	4.3
97A050	FC607 released		2.7	4.3
961011HO	FC607/FC708		3.3	4.7
971020	FC907-1	FC607/FC701 BC_4	3.0	4.7
961011HO1	FC607/FC708CMS		3.7	4.7
921024	FC709-2	released	3.7	4.7
951014	(2890aa & 2859aa) x FC708		3.0	5.0
991003H	CTR/LSRmm		4.0	5.0
921021	FC703-5	released	4.0	5.0
99A002	892012H2		2.7	5.3
991001	RhzcRmmpop; FC708 & 2890,2859 (Salinas)		4.3	5.3
921022	FC702-7	+ 7 cycles Rhizoc	4.3	5.3
861039	FC712	released	4.0	5.3
971018	FC712 (4X)	released	4.3	5.3
991014	Rhizoctonia Res. Multigerm pop (2915/FC709-2)		3.3	5.3
961012HO1	FC712/MonoHy A4 - CMS equivalent		3.7	5.3
981037	LSR/CTR/Sucrose		4.0	5.3
991002PF	RhzcR/LSR/MM/Hspop: 3859, 4918, 278; FC907; FC709-2, FC902 ; MonoHy-T6,A7,& A4; SR87		4.0	5.3
99A006	SR 94	released	4.0	5.3
961012HO	FC712/MonoHy A4		4.7	5.7
951016HO1	FC723CMS	EL44/FC708 CMS	3.7	5.7
961010HO1	FC722CMS	C718/FC708 CMS	4.3	5.7
831085HO	FC708	released	5.0	5.7

Table 8. 1999 Curly Top Nursery in Kimberly Idaho.

Seed Source	Description		Disease Index[1] 08/31/98	Disease Index[1] 09/22/98
911032	**FC718 – Susceptible Check**		**5.0**	**6.0**
94A068	**Beta G6040 – Resistant Check**		**2.3**	**3.7**
99A001	892016H2FC607 OT/Beta 2007 (2X)		4.3	5.7
961013HO	FC506	released	4.3	5.7
921025	FC728	released	4.3	6.0
961015	FC720	C718//(C718/FC708)	4.3	6.0
961010HO	FC722	C718/FC708	5.0	6.0
99A003	EL 52		4.3	6.0
911026HO	FC715	released	4.7	6.0
951017	FC727	released	4.7	6.3
951016HO	FC723	EL44/FC708 mm	5.0	6.3
911031	FC717	released	5.3	7.0

[1]Disease Index is based on a scale of 1 (=healthy) to 9 (=dead).

PRE-BREEDING: THE INTROGRESSION OF NEW SOURCES OF CERCOSPORA LEAF SPOT RESISTANCE FROM *BETA VULGARIS* SPP. *MARITIMA* AND OTHER EXOTIC SOURCES INTO SUGAR BEET-TYPE POPULATIONS. (BSDF Project 443)

L. Panella

A major emphasis of the research mission of the USDA-ARS plant scientists is the collection, documentation, characterization, evaluation, regeneration (maintenance), distribution, and utilization of plant germplasm, especially Plant Introduction (PI) accessions in the USDA-ARS National Plant Germplasm System (NPGS). The Sugar Beet Research Unit at Fort Collins is coordinating the national program for *Beta* germplasm evaluation. In addition to the evaluation for Rhizoctonia and Cercospora resistance, it is crucial that the ARS scientist be involved in the long rang, high risk research problems involved in sugar beet 'germplasm enhancement' or 'pre-breeding'. This is an important component in the overall sugar beet improvement effort of the Fort Collins Sugar Beet Research Unit.

Justification for Research: Cercospora leaf spot (caused by the fungus *Cercospora beticola* Sacc.) is one of the most widespread diseases of sugar beet and is a serious problem in many sugar beet production areas throughout the U.S. The disease damages the leaves, which, consequently, reduces root yield, percent sucrose of roots, and purity of the extracted juice. Cercospora leaf spot currently is controlled by combining spraying with commercial fungicides and the use of disease tolerant germplasm. The development of Cercospora leaf spot resistant sugar beet lines and hybrids with greater levels of host-plant resistance offers a more sustainable solution to this disease problem.

If the level of resistance available in some Cercospora-resistant experimental breeding lines were present in commercial hybrids (**along with good sugar and seed yield**), the need for fungicides could be greatly reduced. That continued improvement in genetic resistance to this serious pathogen is still needed is evident by the occurrence of *Cercospora* strains that are tolerant to our most potent fungicides. Additionally, some fungicides may be removed from the market because of their perceived or real threat to the environment.

Finally, the genepool for resistance to Cercospora leaf spot is extremely narrow. Many of the resistant lines are highly inbred, therefore, closely related to one another, and stem from germplasm coming out of Italy in the early 1900s. In the germplasm developed at Fort Collins, continued inbreeding has increased the level of disease resistance, but at the cost of plant vigor. Over the long term, a secure, sustainable response to this disease requires commercial quality hybrids with good host-plant resistance.

Objectives:

1. The formation of long range breeding populations through the introgression of Cercospora resistant germplasm from "exotic" sources (*Beta vulgaris* spp. *maritima*, fodder beet, foreign sugar beet landraces from the PI collection, etc.).

2. The development of germplasm populations from these long range populations that are of sufficient agronomic quality to be of use to commercial breeders. They will be a source of

leaf spot resistance with differing genetic backgrounds.

3. The development of techniques (both traditional and molecular) to more efficiently introgress the exotic germplasm into sugar beet breeding populations.

Research Progress 1999:

Crosses have been made or are being attempted in the greenhouse on the list of accession below, all of which have been identified as having Cercospora resistance. F_2 is being planted from the F_1 populations, where sufficient seed is available. F_2 seed of three crosses (96A011, 96A015, and 96A016 as donor parents) has been bulk increased in the greenhouse and this is being planted to produce F_3 populations. All three show some biennial plants in our environment and were crossed to genetic male sterile (*aa*) sugar beets. These F_1 increases should be completed by the beginning of 2001. We are considering re-crossing some of those from which we obtained insufficient F_1 seed, but will concentrate primarily with those populations from which we have sufficient seed.

Plants from those populations producing some biennial plants are being vernalized for 90 days and the populations are being increased (i.e., random mated using the genetic male sterility where possible). The annuals will be handled in a similar fashion once the F_1 populations have been increased. All will be cycled through at least three cycles of random mating.

Accession Number	Donor Designation	Name or Origin	% Bolting without induction 1996 Fort Collins	F_1 Population	F_2 Population
96A010	PI 535826	Giant Poly	20%	971021H2	981031 F_3=991026
96A011	PI 535833	Saturn	0%	unsuccessful	
96A014	PI 540593	WB 847	0%	971023H2	
96A015	PI 540596	WB 850	70%	971024H2	981032
96A017	PI 540605	WB 859	25%	971025H2	
96A012	PI 535843	PN MONO 1	100%	971026H2[1]	
96A013	PI 540575	WB 829	100%	971027H2[2]	
96A016	PI 540599	WB 853	50%	971028H2	981033
94A079	#32375 (*B. v.* ssp. *maritima*)	Greece	annual	971029H2	
94A080	#36538 (*B. v.* ssp. *maritima*)	Greece	annual	971030H2[3]	
94A081	#45511 (*B. v.* ssp. *maritima*)	Greece	annual		
94A082	#45516 (*B. v.* ssp. *maritima*)	Greece	annual	981002H3	
94A083	#48810 (*B. v.* ssp. *maritima*)	Tunisia	annual		
94A084	#48819 (*B. v.* ssp. *maritima*)	Tunisia	annual	981004H2	
94A085	#51430 (*B. v.* ssp. *maritima*)	Greece	annual	981005H3	

[1]Only 16 seed balls produced.
[2]Only 10 seed balls produced.
[3]Only 60 seed balls produced.

Development of a resistant germplasm line generally takes seven years. A longer time will be necessary to incorporate disease resistance from more exotic sources. Because this is a new program it will take time for the first germplasm to make it through the process. Once that happens, there will be a "pipeline" of germplasm in various stages of development and the release of new germplasm will occur every two to four years. The incorporation of exotic sources into agronomically acceptable germplasm is a long term proposition - results will not appear overnight. This is the type of long-term, high risk germplasm research that ARS is well-suited to perform.

Materials and Methods: Artificial inoculation with *Cercospora beticola* and leaf spot scoring will be used to identify the resistant germplasm sources and make selections in the developing populations. The exotic materials will be crossed into sugar beet populations that have been selected for agronomic quality (recoverable sucrose yield). These are currently under development using germplasm received from commercial breeding programs, public sources (e.g., L19), and some high sucrose germplasm from Poland. These sugar beet populations will be self-fertile (S^f) and segregating for nuclear male sterility (*A-:aa*). Populations will be handled in the following manner: 1) Following the initial cross, a population will be random mated (using *aa* females because of the self-fertility) for three to four generations to break up linkage groups and remove annual plants. 2) Sugar beet-type mother roots will be selected, selfed, and progeny tested for agronomic performance and disease resistance. 3) Selected roots will be recombined (and backcrossed if desirable) and re-selected until they ready for release. Molecular markers (RFLPs, RAPDs, SSRs, AFLPs, etc.) will be used to expedite the backcrossing program and to follow the change in allele frequencies in the selected populations. Advanced populations will be released to the sugar beet seed industry.

Summary of Literature: Cercospora leaf spot has been an intermittent problem in sugar beet growing areas of the United States where the summers can be hot and humid (Red River Valley, Michigan, Ohio, and, less often, Great Plains growing areas and California). It has been estimated that a severe epidemic can cause up to a 42% loss of gross sugar (Smith and Martin, 1978; Smith and Ruppel, 1973), or up to a 43% relative dollar loss (Shane and Teng, 1992).

Resistance to Cercospora leaf spot has long been a goal of the USDA-ARS sugar beet research program at Fort Collins and researchers there developed the techniques necessary to manage the screening nurseries in such a way as to promote the development of the disease (Ruppel and Gaskill, 1971). A careful crop rotation (sugar beet-barley-barley-barley-sugar beet) and the arid climate and low relative humidity have allowed this to be done in such a manner that there are rarely high enough levels of any other disease present in the leaf spot nursery to confound the results.

There are an estimated 4 or 5 genes responsible for *Cercospora* resistance (Smith and Gaskill, 1970) and broad-sense heritability estimates ranged from 12 to 71% (Bilgen et al., 1969). Narrow-sense heritability estimates of about 24% compared well with realized heritability values, and 44 to 62% of the variation was due environment in this test (Smith and Ruppel, 1974). The large environmental variation has made it difficult to make progress in developing *Cercospora* resistance through mass selection. Incorporation of high levels of leaf spot resistance into varieties with superior agronomic performance also is difficult (Smith and Campbell, 1996) and, therefore, commercial resistant varieties require some fungicide application to provide adequate levels of protection against Cercospora (Miller et al., 1994).

A major problem in the development of *Cercospora*-resistant sugar beet is the loss of vigor due to the continual inbreeding. Coons (1955) noted this and it has been a concern ever since (McFarlane, 1971). The use of hybrid varieties has ameliorated this problem to some extent, but seed production on the highly inbred O-type males and CMS females still is a problem. This is seen in germplasm from both the FC 500 and FC 600 series developed at Fort Collins.

The USDA-ARS National Plant Germplasm System *Beta* collection has over 2,000 Plant Introduction (PI) accessions. The germplasm used most often in sugar beet breeding is from *Beta vulgaris* spp. *vulgaris*, which includes all of the biennial sugar beet types, or from *Beta vulgaris* spp. *maritima*, which contains the closely related wild sea beet and has both annual and biennial types. Germplasm with a biennial flowering habit is easier both to introgress and screen. *Beta vulgaris* spp. *maritima* has, nonetheless, been used as a source of resistant germplasm. Much of the *Cercospora*-resistant germplasm in use today came out of Munerati's program in Italy, in which *B. vulgaris* spp. *maritima* was the source of resistance genes (Lewellen, 1992). There have been very few new efforts to locate and incorporate other sources of resistance to *Cercospora* into this narrow germplasm base.

There is an urgent need to continue to create in our *Cercospora*-resistant germplasm a broader genetic base than we have today. As commercial hybrid parents become more inbred, the germplasm base from which these inbred parents are developed must have the diversity necessary to provide for maximum gain through heterosis. Munerati's success, and the research of others, has shown that it can be done if we have the persistence to do it (Bilgen et al., 1969; Doney, 1993; Lewellen, 1995).

Bilgen, T., J.O. Gaskill, R.J. Hecker, and D.R. Wood. 1969. Transferring *Cercospora* leaf spot resistance from *Beta maritima* to sugarbeet by backcrossing. J. Am. Soc. Sugar Beet Technol. 15:444-449.

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Smith, G.A. and E.G. Ruppel. 1974. Heritability of resistance to *Cercospora* leaf spot in sugarbeet. Crop Sci. 14:113-115.

SUGAR BEET RESEARCH

1999 REPORT

Section C

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CONTENTS

Status report on the *Beta* germplasm collection activities at the USDA, ARS, Western Regional Plant Introduction Station To the Beet Sugar Development Foundation Curator: Dr. Alan Hodgdon, 2000

Thirty-nine accessions harvested at W-6 in 1999 have been cleaned and weighed. Of these, thirty-six were increased in the greenhouses. Three of these accessions will have to be redone. Only three accessions were successfully increased in the field due to very bad growing conditions. Twenty-five plots froze during the winter, and several surviving plots did not flower well during the heat of the summer. Fifty-four accessions were started at W-6 in 1999. In all, 110 accessions are in the process of increase. The increase priority list has 448 accession as of the end of 1999. Twelve accessions are being increased by seed companies in the U.S. This help is greatly appreciated. Field increases at W-6 have been a problem with poor plant numbers, poor quality seed, and low seed yield.

In the future we will try artificial vernalization, and then spring plant in at our Pullman site. This could solve the problem of plot freeze-out and provide a cooler weather grow-out site. I am not optimistic about this solution since our growing environment is a poor match with that of the wild beets, particularly *Beta maritima*. With the greenhouse increases, we have had good seed yield and quality, but progress has been slowed by deinduction of flowering especially with the wild beets. We are working on changing the post-vernalization conditions to improve flowering.

SEED GERMINATION

One hundred-five *Beta* seed samples were tested for germination in 1999. The seed lab is using a dry germinator which gives better results. No specific seed germination data is available now. However, no sample had less than 20% germination, and most samples were higher than 50%.

SEED STORAGE ACTIVITY

W-6 distributed 643 samples from the *Beta* collection in 1999, and we acquired thirty- one new accessions. There was no new backup activity for the *Beta* collection.

SUGARBEET RESEARCH

1999 Report

SECTION D

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CONTENTS

PUBLICATIONS

Abstract of Papers Presented or Published

CAMPBELL, L.G., G.A. SMITH, J.D. EIDE, AND L.J. SMITH. 1999. *Metarhizium anisopliae* as a biocontrol agent for sugarbeet root maggot. J. Sugar Beet Res. 36(3):55.

Only a few insecticides are available for controlling the sugarbeet root maggot (*Tetanops myopaeformis*). These could become less effective because of the development of resistant root maggot strains or become unavailable because of environmental concerns. An effective biocontrol agent would provide an alternative and, perhaps, more consistent control method. Laboratory results and a 1995 field trial prompted further testing of the entomopathogenic fungus *Metarhizium anisopliae* (Metschn.). *Metarhizium* inoculum was prepared by culturing the fungus on heat-killed barley. The inoculated barley was spread evenly over field plots in the fall proceeding the sugarbeet crop, in the spring prior to planting, or both in the fall and spring. Root yields ranged from 49.5 Mg ha^{-1} when no insecticide was applied to 59.2 when Lorsban (chlorpyrifos) was used to control maggots. The fall, spring, and fall plus spring applications of *Metarhizium* yielded 51.5, 50.9, and 58.9 Mg ha^{-1}, respectively, at Crookston in 1996. The 1997 trials included the same three *Metarhizium* treatments with an additional application of *Metarhizium* in the spring of 1996 (prior to planting barley). Root yields for the *Metarhizium* treatments ranged from 51.4 to57.6 Mg ha^{-1}, compared to 57.5 Mg ha^{-1} when Lorsban was applied and 48.7 Mg ha^{-1} in the absence of maggot control in 1997. Yield differences between treatments were not significant in 1998 because of reduced root maggot pressure, but appeared to follow the pattern observed in the 1996 and 1997 trials. Results, to date, have been encouraging; however, additional information on application rates and timing, formulations, and the effectiveness of *Metarhizium* in more environments will be required before commercialization is feasible.

CAMPBELL, L.G., A.W. ANDERSON, L.J. SMITH, AND R. DREGSETH. 1999. Root yield losses associated with sugarbeet root maggot damage. J. Sugar Beet Res. 36(1-2):56.

Sugarbeet root maggot, *Tetanops myopaeformis*, is the major insect pest of sugarbeet in Minnesota and Eastern North Dakota. Root maggot damage is routinely rated on a 0 (no damage) to 5 (severe) scale. Forty-two trials were utilized to examine the relationship between visual damage and root yield. The mean damage rating in the absence of insecticides was 3.3, compared to a mean of 1.7 for the highest yielding treatment in each trial. Mean root yield of the highest yielding treatment in each trial was 48.8 Mg ha^{-1}, compared to a mean of 29.0 Mg ha^{-1} when no insecticides were applied. Regression analyses within individual trials indicated the yield loss associated with each increment of the damage rating scale fluctuated widely, ranging from near zero to 15.7 Mg ha^{-1}. The percent yield reduction in the absence of

insecticides ranged from 9.8% to 83.6% when compared to the treatment providing the most effective control in each test. The regression equation from a combined analysis indicated that little or no yield loss occurs with damage ratings below 1.4. These results are useful in estimating losses, developing recommendations, and providing a standard of comparison for alternative control strategies.

KLOTZ, K.L. 1999. Sucrose metabolizing enzymes and sucrose losses in sugarbeet. Sugarbeet Research and Extension Reports, p.145-147.

Developmental changes in the activities of the major sucrose catabolizing enzymes of sugarbeet roots were determined. In seedling roots, the acid invertases were the predominant sucrolytic enzymes. Soluble and insoluble acid invertase activities were greatest in two week old sugarbeet roots. After two weeks, their activities dropped precipitously to nearly negligible levels. Soluble acid invertase activity was due to a single isoenzyme. Alkaline invertase activity was also greatest in two week old roots. Alkaline invertase, however, was present only at low levels throughout development. Two alkaline invertase isoenzymes were present at all developmental stages, but their relative contribution to total alkaline invertase activity changed with root development. Sucrose synthase was the major sucrose utilizing enzyme in sugarbeet roots six weeks of age or older. Two sucrose synthase isoenzymes contributed to sucrose synthase activity. Only one sucrose synthase isoenzyme was evident during the first twelve weeks of growth. Two sucrose synthase isoenzymes were present after sixteen weeks.

WEILAND, J. J. AND SUNDSBAK, J. L. 2000. Differentiation and detection of sugarbeet fungal pathogens using PCR amplification of actin coding sequences and the ITS region of the rRNA gene. Plant Disease. 84:475-482.

The DNA sequences of the actin genes of several fungi were compared and highly conserved regions in the coding sequence were identified. Deoxyoligonucleotide primers were synthesized based on conserved sequence blocks in the 5' and 3' ends of the open reading frame encoding the actin protein. In addition, primers (ITS1 and ITS4) based on conserved regions of the ribosomal RNA (rRNA) genes of fungi were synthesized. Use of the primers in the polymerase chain reaction (PCR) resulted in the amplification of DNA products from the genomes of sugarbeet fungal pathogens of a size consistent with the amplification of the actin gene and rRNA gene sequences, respectively, in these fungi. With one primer pair (5FWDACT and MIDREVACT) directed to the actin gene , the major products amplified from the DNA of *Aphanomyces cochlioides*, *Pythium ultimum*, *Cercospora beticola*, *Phoma betae, Fusarium oxysporum,* and *Rhizoctonia solani* were of the sizes of 0.9, 0.9, 1.1, 1.1, 1.2 and 1.7 kilobasepairs (kbp), respectively, whereas no product was generated from the DNA of sugarbeet (*Beta vulgaris* L.). Restriction endonuclease digestion of products amplified using 5FWDACT and MIDREVACT permitted the differentiation of *A. cochlioides* from *A. euteiches*. Use of ITS1 and ITS4 in PCR

reactions employing the same template DNAs and reaction conditions yielded single products of 0.7, 0.8, 0.5, 0.5, 0.6, and 0.7 kbp, respectively, as well as a 0.7 kbp product from DNA of sugarbeet. The data indicate that actin and rRNA gene sequences are appropriate targets for the development of PCR-based strategies for distinguishing sugarbeet fungal pathogens at the genus level. The presence of *A. cochlioides* DNA in extracts of diseased sugarbeet seedlings was detected using PCR with primers 5FWDACT and MIDREVACT.

WEILAND, J.J. 2000. A survey for the prevalence and distribution of *Cercospora beticola* tolerant to triphenyltin hydroxide and mancozeb and resistant to thiophanate methyl in 1999. 1999 Sugarbeet Research and Education Reports, Cooperative Extension Service, North Dakota State University. 30:236-239.

Triphenyltin hydroxide (TPTH) has been used extensively in the Northern Great Plains in recent years for the control of *Cercospora* leaf spot on sugarbeet. Although mancozeb and, to a lesser extent, the benzimidazole fungicides often are implemented in conjunction with TPTH for optimum leaf spot control, TPTH continues to be the most widely used compound for control of the disease. Testing in our USDA-ARS Fargo laboratory of *Cercospora* that was isolated from leaf spot in the sugarbeet fields in North Dakota and Minnesota for the tolerance or resistance to fungicides first revealed tolerance to TPTH in 1994. The testing program has continued to the present and now includes surveying for tolerance to mancozeb. Testing for baseline tolerance to tetraconazole is also beginning this year, as this represents new chemistry available to the grower for the control of leaf spot disease. As in previous years, fields in the southern Minnesota growing region and in all factory districts from Wahpeton to Drayton in the Red River Valley were surveyed. Samples were tested for resistance to thiophanate methyl (TM; a benzimidazole fungicide) and for tolerance to TPTH and mancozeb at two different exposure levels.

WEILAND, JOHN J., AND ROBERT T. LEWELLEN, J. MITCH MCGRATH, LEE PANELLA, AND MING H. YU. 2000 tagging of disease resistance genes in sugarbeet (*beta vulgaris* L.) With molecular genetic markers. Abstracts of the Plant and Animal Genome VIII Meeting. p45 of Abstract Book.

Resistance to numerous diseases pests in sugarbeet appear to be conferred by monogenes. These include resistance to powdery mildew, Erwinia vascular necrosis, beet mosaic virus, and Fusarium stalk rot. The inheritance of resistance to the cyst nematode, *Heterodera schachtii*, is monogenic and the inheritance of resistance to the root knot nematode is being evaluated. These pathosystems are being used as models for the generation of molecular genetic markers tagging genes for disease resistance in sugarbeet. Markers generated from the study will be used to evaluate the linkage and location in the sugarbeet genome of genes conferring resistance to several pathogens. In addition, the markers will be useful in the introgression of disease resistance genes into sugarbeet parent lines using marker-assisted selection

and in future cloning and analysis of these genes. The use of resistance gene analog (RGA) sequences is being incorporated into the resistance gene detection strategies. Such sequences may permit the identification of quantitative trait loci that contribute to genetically-complex resistance in sugarbeet to rhizoctonia root rot, Cercospora leaf spot, and aphanomyces black root diseases. The status of a project aimed at tagging a monogene conferring resistance to powdery mildew in sugarbeet caused by *Erysiphe polygoni* DC will be presented.

WEILAND, J. J. AND LEWELLEN, R. T. 1999. Generation of molecular genetic markers associated with resistance to powdery mildew (*Erysiphe polygoni* DC) in sugarbeet (*Beta vulgaris* L.). 9th International Congress on Molecular Plant-Microbe Interactions. July 25-30th, 1999, Amsterdam, The Netherlands.

Powdery mildew caused by *Erysiphe polygoni* DC can be devastating to sugarbeet production particularly in warm, dry climates. Although resistance to certain races of *E. polygoni* exists in sugarbeet, powdery mildew disease is typically controlled though the use fungicides. The identification of broad resistance to sugarbeet powdery mildew in the wild beet *B. vulgaris* spp. *maritima* was followed by the incorporation of this resistance into sugarbeet by recurrent backcrossing and progeny testing. Germplasm accession C37 was used as the susceptible, recurrent parent and P604 is the F_2BC_3 population at the intermediate stage of the introgression. Three DNA pools each were produced for C37 and P604; each pool was comprised of the DNA from 7 individual plants. A diprimer adaptation of the RAPD analysis was applied to the DNA pools, where one of the primers was composed of a sequence homologous to that encoding a core sequence found in many plant disease resistance genes. Amplified products were identified that were associated with all three DNA pools derived from P604 plants, but with none of the three DNA pools derived from C37. The possibility that some of the amplified products contain sequences of the gene conferring resistance to sugarbeet powdery mildew is discussed.

CHARACTERIZATION OF GENE AND GENE PRODUCTS INVOLVED IN CERCOSPORA RESISTANCE IN SUGARBEET.

Project 601

John J. Weiland

A glucanase enzyme induced in sugarbeet that is infected with *Cercospora beticola* was identified during the course of the project. Using protein sequence data of the enzyme, PCR primers designed for the gene are being used to clone the gene sequences. Once cloned, the sequences can be used as a probe to examine the association of resistance to Cercospora leaf spot disease in sugarbeet populations segregating for this trait.

Elaboration of the approaches outlined in project 601 and application of these approaches to numerous pathogens of sugarbeet are the topic of a new proposal being submitted to the BSDF by J. Weiland ("Mechanisms of resistance in sugarbeet to fungal and bacterial pathogens"). Fundamental to the new project is the use of molecular biology techniques to determine important biochemical players in the defense of sugarbeet from pathogen attack.

Direct biochemical evaluation of the defense process remains an integral component of the analysis. Novel changes in the pattern of isozymes of esterase, acid phosphatase, and peroxidase have been shown to be associated with infection by *C. beticola* (Fig. 1). Those activities that exhibit the most drastic changes as a result of fungal infection will be examined in greater detail using time-course studies. A comparison of the regulation of these activities in leaf spot susceptible and leaf spot resistant germplasm will point to candidate genes underlying the resistance.

By incorporating molecular biology into the analysis of the biochemistry of resistance, novel genes that may confer resistance to sugarbeet through genetic engineering or other means will be more readily obtained. As an example, the cloning of the *sor* (singlet-oxygen resistance) gene from *C. beticola* in our laboratory may find use in engineered sugarbeet for enhancing leaf spot resistance. In addition, a polygalacturonase inhibitor protein (PGIP) gene from *Beta webbiana* has been amplified by PCR and cloned in our lab (Fig. 2). The future tailoring of potential antifungal proteins such as the PGIP gene using recombinant DNA techniques may lead to the development of antifungals with broad spectrum actives against many sugarbeet pathogens.

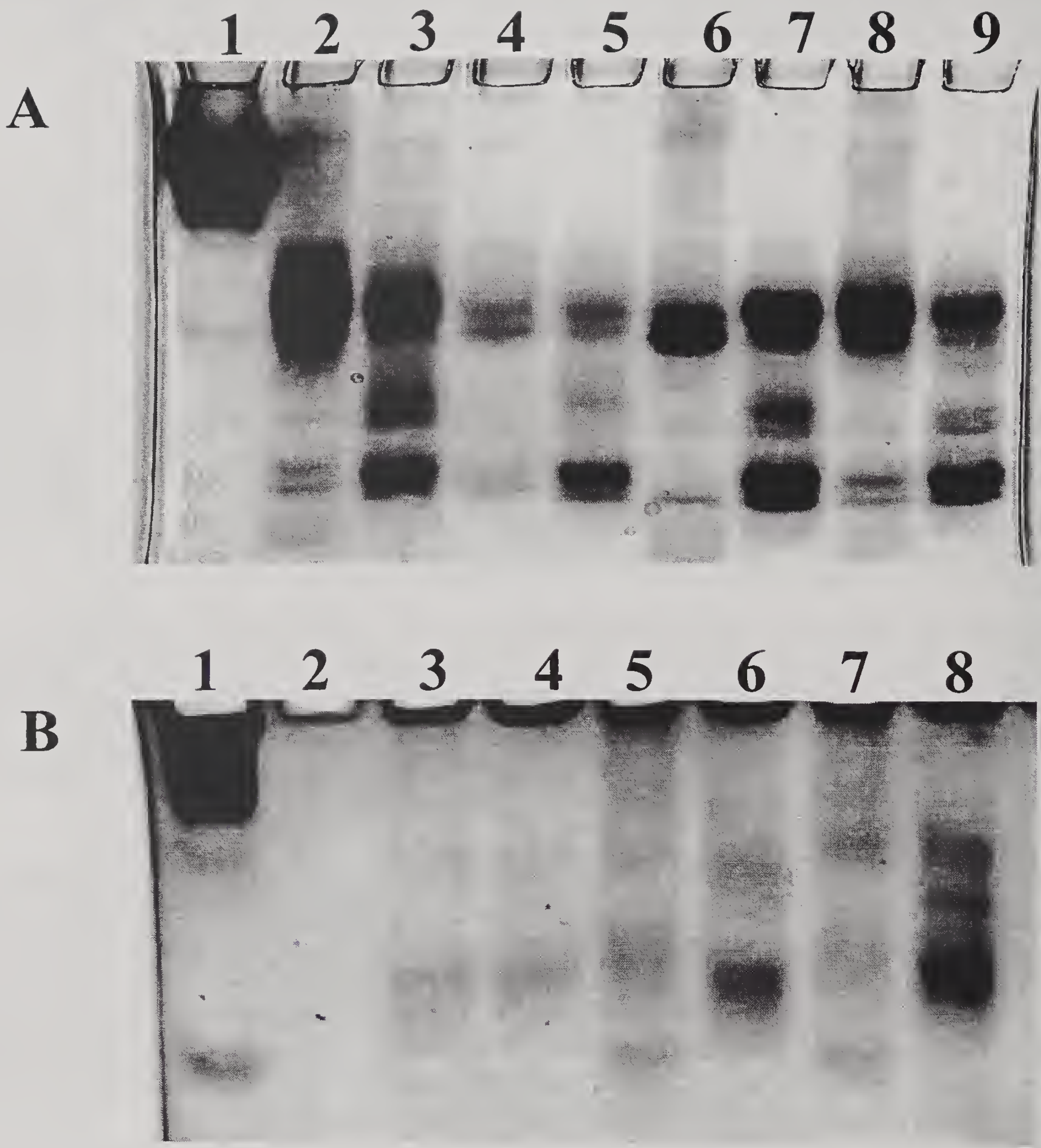

Figure 1. Sugarbeet isozymes of peroxidase (A) and esterase (B) separated by native polyacrylamide gel electrophoresis. In A, even numbered lanes represent extracts of healthy sugarbeet tissue from germplasm of Ultramono (lane 2), BS-S (4), BS-R, (6), and FC607 (8). Extracts from Cercospora lesions on leaves were made and run in lanes 3,5,7,9, representing (in order) the same germplasm sources. Horseradish peroxidase was run in lane 1. The gel was stained with 3-amino-9-ethylcarbazole. For the esterase gel in B, an extract from cultured C. beticola was run in lane 1. Extracts of healthy leaf tissue from sugarbeet Ultramono (lane 8) and FC607 (6) are compared to extracts from Cercospora lesions in lanes 7 and 5, respectively. Lane 4 represents an extract of healthy Ultramono tissue which is compared to the extract in lane 3 from necrotic Ultramono tissue resulting from infiltration with 100 μM purified cercosporin toxin. Esterase activities were visulized by UV light after treatment of the gel with 4-methylumbelliferyl butyrate. In both A and B, note changes in isozyme pattern after infection with *C. beticola.*

```
pir||S47965 polygalacturonase inhibitor protein - tomato >gi|469457 (L26529)
            polygalacturonase inhibitor protein [Lycopersicon
            esculentum]
            Length = 327

 Score =  184 bits (462), Expect = 1e-45
 Identities = 113/301 (37%), Positives = 156/301 (51%), Gaps = 31/301 (10%)

Query: 32  CNPQDKKALLEIKHHFHNASAFSNWDPNTDCCSDWFGILGCDSHGR------ILQLDISS 85
            CNP+DKK LL+IK    N    ++WDPNTDCC  W+ ++ CD          + Q +IS
Sbjct: 23  CNPKDKKVLLQIKKDLGNPYHLASWDPNTDCCY-WY-VIKCDRKTNRINALTVFQANISG 80

Query: 86  R--------------------NLTG-IPSSLGQLHKVNTILLNSNNLSGRIPSFFSFMKS 124
            +                    NLTG IP ++ +L  +  + L+  NL+G IP F S +K+
Sbjct: 81  QIPAAVGDLPYLETLEFHHVTNLTGTIPPAIAKLTNLKMLRLSFTNLTGPIPEFLSQLKN 140

Query: 125 LQSY-LYDNQLTGMIPSSLARLPKLLDINLGYNQLTGSIPQXXXXXXXXXXXXXXLYFNK 183
            L    L  NQ TG IPSSL++LP LL + L  N+LTG+IP+              L  N
Sbjct: 141 LTLLELNYNQFTGTIPSSLSQLPNLLAMYLDRNKLTGTIPESFGRFKGPNIPDLYLSHNS 200

Query: 184 LSGPIPRSFGKXXXXXXXXXXXXMFTGDASNLFSRDNMELFSIDISSNRFHFDFSKVVLSR 243
            L+G +P S G               GD S LF ++      ID+S N   FD SK   +
Sbjct: 201 LTGHVPASLGDLNFSTLDFSRNKLEGDVSFLFGKNKTSQV-IDLSRNLLEFDISKSEFAE 259

Query: 244 KLVYLNVSHNAIYGSLPKNLGQLSLQRIDVSFNQLCGKIPTGRRLKQFSPALFSHNKCLC 303
            L+ L+++HN I+GSLP  L  + LQ  +VS+N+LCG+IP G  L+ F    + HNKCLC
Sbjct: 260 SLISLDLNHNRIFGSLPPGLKDVPLQFFNVSYNRLCGQIPQGGTLQSFDIYSYLHNKCLC 319

Query: 304 G 304
            G
Sbjct: 320 G 320
```

Figure 2. A putative polygalacturonase inhibitor protein (PGIP) sequence predicted from the DNA sequence of clone amplified from *Beta webbiana*. Oligonucleotide primers were made based on conserved regions of PGIP genes from other plant species. The amplified DNA from *B. webbiana* was cloned and the sequence obtained by standard methods. BLAST-based search of the Genbank sequence database with the translated DNA sequence revealed similarity to PGIP genes from other plants. The "Query" sequence is that from *B. webbiana*, whereas the "subject" sequence found by the search is from tomato (*Lycopersicon esculentum*).

DEVELOPMENT OF A GREENHOUSE ASSAY FOR RESISTANCE TO RHIZOCTONIA ROOT ROT

Project 610

John J. Weiland and Lee Panella

Methods for the evaluation of sugarbeet for resistance to root rot caused by Rhizoctonia solani AG2-2 presently involve the generation of disease in replicated field plots. The development of a resistance screening method that could be performed in the growth chamber or greenhouse would enable researchers to evaluate candidate breeding lines for levels of resistance before use in test hybrids. In recent years, the ARS lab in Fargo has refined a technique for the inoculation and rating of young roots with *R. solani* AG2-2. A protocol was presented last year that permits roots of test germplasm to be evaluated at 8 weeks post-seeding. Ranking of test germplasm according to levels of disease was similar to that observed for the performance of the accessions in the root rot disease nursery at Fort Collins, CO.

The techniques for inoculation and plant rating are as follows. Briefly, one or two sugarbeet plants are grown in 6" pots to the 5 week-old stage in a greenhouse that is maintained at an average temperature of 25°C and alternating between a 16 hr day period and an 8 hour dark period. Since 50 roots are inoculated per trial, the rearing of at least 60 plants is recommended. Two weeks prior to plant inoculation, *R. solani* AG2-2 is plated onto potato dextrose agar and incubated at 22°C in the dark. One week prior to inoculation, sterile barley grain is sprinkled onto the plated *R. solani* culture and the plates are sealed with Parafilm and returned to the incubator. The barley grains become infested with the fungus within one week. For the inoculation, two infested barley grains are place next to the root surface of a 5 week-old sugarbeet plant at ~2 cm below the surface of the soil. The soil is replaced over the grain inoculum and the plants are watered immediately after all of the plants have been inoculated.

One week after inoculation, plants of a highly susceptible check accession or variety are examined at 3-day intervals in order to monitor disease progress. When greater than 50% of the roots of this accession exhibit severe root rot (>90% of root surface exhibiting rot), all of the roots in the experiment are dug up and rated for root rot severity. This typically occurs at about 14 days post-inoculation. A 0 to 4 scale is used for evaluating root rot severity, where a plant exhibiting no disease is considered a 0 reaction, a root lesion effecting 10% or less of the root surface is a 1 reaction, a root lesion covering 11 – 50% of the root surface is a 2 reaction, root rot covering 51-89% of the root surface is a 3 reaction, and rot on ~90% of the root surface or the plant is dead represents a 4 reaction. By multiplying the data by 7/4, a comparison can be made between the data obtained using the 0-4 scale with that using the 0-7 scale employed at the Fort Collins disease nursery.

In 1999, the technique for evaluating sugarbeet roots for resistance to *R. solani* was applied to a mapping population developed by J.M. McGrath (ARS-East Lansing) and segregating for resistance to Rhizoctonia root rot was evaluated using the greenhouse method. Highly resistant and highly susceptible progeny from the cross will be used to identify molecular genetic markers that co-segregate with root rot resistance. Use of such markers could significantly reduce costs in a breeding program, by substituting marker detection for disease screening. In addition, crosses were initiated between FC403cms, possessing low root rot resistance, and the highly root rot resistant FC709-2,

both produced at the ARS Fort Collins nursery. Interpollination between F1 progeny from this cross will yield F2 progeny varying in resistance to *R. solani*. Highly susceptible and highly resistant F2 progeny will be used for the preparation of DNA and tagging of loci contributing to root rot resistance in sugarbeet using accepted marker methods (amplified fragment length polymorphism, random amplified polymorphic DNA, etc.). Application of DNA marker technology to genetic resistance in sugarbeet to *R. solani* and other fungal pathogens of sugarbeet will be continued in 2000 under a new project sponsored by the BSDF.

POLYMERASE CHAIN REACTION (PCR)-BASED DETECTION OF *APHANOMYCES COCHLIOIDES* USING ACTIN GENE SEQUENCES.

Project 620

John J. Weiland

A number of soil fungi have the capability to cause disease in sugarbeet and these include *Rhizoctonia solani*, *Aphanomyces cochlioides*, *Pythium aphanidermatum*, *P. ultimum*, and *Fusarium oxysporium*. When seedling damping off or adult plant root rot occur, diagnosis of the causal agent of the disease can be a time-consuming process (days to weeks). Culture of the organisms from an infected area of the sugarbeet root can lead to the recovery of a plethora of fungi, many of which have colonized the infected tissue as saprophytes.

The polymerase chain reaction (PCR) is a DNA based technique for amplifying specific sequences from the genomes of organisms. PCR technology has impacted many fields of biology, including the area of disease diagnosis in both plants and animals. Diagnostics using the PCR are sensitive and highly discriminatory, since they target genome regions whose DNA sequences have diverged throughout evolution. PCR-based diagnostics also require little time for a result to be secured (within one to two days), making them attractive to high-throughput diagnostic laboratories.

The interests in our laboratory include the development of novel diagnostic tools for disease-causing fungi in sugarbeet, as well as the development of tools for investigating the biochemistry of sugarbeet pathogenesis by fungi. For this reason, we designed our PCR assay for the discrimination of sugarbeet fungal pathogens upon DNA sequences of the actin gene. Actin is a protein found in all eukaryotes and the gene coding for actin possesses sequence blocks of both high similarity, as well as of high divergence, across all eukaryotes. This facilitates the design of DNA "primers" that recognize the highly similar sequences in order to detect potential size variation in the actin gene that can be used to "fingerprint" and discriminate one sugarbeet pathogen from another. Actin is also a highly expressed gene and the cloning and re-engineering of actin gene sequences might provide a useful tool for gene transfer studies with sugarbeet fungal pathogens.

In 1999, the results of application of the PCR technique to all major sugarbeet fungal pathogens was summarized (see Weiland and Sundsbak in Publications section). Future work will focus on the design of primers that will permit the robust detection of *A. cochlioides* without amplification of DNA from potentially contaminating DNA from *A. euteiches* or other resident fungi. In addition, observations of DNA polymorphism within the actin gene will be used in conjunction with amplified fragment length polymorphism (AFLP) data in *A. cochlioides* and virulence data in order to assess genetic diversity of *C. beticola* in sugarbeet in the U.S.

THE DEVELOPMENT OF DYNAMIC GENE POOLS FROM *BETA MARITIMA* SOURCES

Project 630

Larry G. Campbell

Since heterosis generally is enhanced by increasing the genetic diversity of the parents, the introduction of desirable germplasm from previously unused sources is essential to the success of long-range hybrid development programs. Because of its background and the need for specific characteristics such as cytoplasmic male sterility, monogerm, and different disease resistance, the sugarbeet breeding pools are believed to be genetically limited (Lewellen, 1992). Although there appears to be sufficient variability for short term gains, long term progress may very well depend upon the infusion of additional variation into the crop.

Potential sources of genetic variation not now being utilized fully include 1) old land races of sugarbeet, table beet, and fodder beet; 2) new naturally occurring or induced mutations; and 3) wild relatives. New sources of genetic variation should produce fertile offspring when crossed with sugarbeet and be genetically unique and diverse, compared to commercial sugarbeet. Of the wild relatives, *Beta maritima* best fits these criteria. In its native habitat, *B. maritima* persists in numerous environments. Its adaptation to this range of environments has resulted in the accumulation of stress response traits different from cultivated beet. Over the past 20 years many representatives of this species have been collected, preserved, and made available to breeders. Several breeders (Manerati, Dahlberg, Lewellen, and Doney) have successfully incorporated genes from this wild form into sugarbeet.

The objective of this research project is the development of populations that incorporate some of the genetic diversity from wild *Beta* into sugarbeet. The goal is to produce populations with root characteristics and sucrose concentrations similar to commercial sugarbeet.

Crosses Between Released Fargo Lines and L19

Y317, y318, y322, and y387 are released germplasms (Doney, 1995) derived from the cultivated / maritima cross, L53cms / PI 546420. PI 546420 was collected near Thessaloniki, Greece in 1978. It is a multigerm, non-O type, annual with prostrate growth habit. Testcross hybrids between the released lines and L33 were deficient in sucrose concentration, compared with commercial hybrids. Because of this, it was decided to cross the above germplasm lines to L19 (Theurer, 1978). L19 is noted for its ability to produce hybrids with relatively high sugar concentrations. Its parentage includes the Polish variety 'Udyca'.

Fifty-six families (entries) were grown at Prosper, North Dakota in 1996. Each entry traced back to a single selfed F_1 plant with the pedigree: L53cms / PI 546420 // L19. These families had an average sugar content of 13.3%; ranging from 8.4 to 15.9%. Recoverable sugar per ton of beets ranged from slightly below 100 to 298 lbs. per ton with an average of 237 lbs. per ton.

Individual roots of all entries were sampled for sucrose concentration. The mean of the 842 roots sampled was 14.56%. Entry means of the 56 entries ranged from 10.7 to 17.1% sugar. Selection was based upon both family mean and individual root sucrose within a family. The selected families had means greater than 14.4%. Individual root sucrose concentrations ranged from 7.4 to 19.4% prior to selection. Selected roots ranged from 14.6 to 19.4% with a mean sugar percent of 16.1% or 1.6% higher than the unselected roots. There were 339 roots from 30 entries selected for increase.

Each of the 30 selected entries was maintained as an entity. Eight to 15 roots were selected from each entry for increase in the greenhouse (1997). Seed from plants within an entry (average of 11 plants / entry) was bulked for testing in replicated field tests in 1998. Data from the 1998 trial was of limited value because of conditions related to the extremely wet spring of 1998.

Twenty-four of these 30 families were evaluated in replicated trials again in 1999, using remnant seed from the 1997 greenhouse increase. A number of the lines appear to have higher sugar concentrations than the wild/cultivated parent but are not yet equal to most commercial hybrids (Table 1). Individual roots from 14 of the lines were sampled for sugar concentration. Of the 336 roots sampled 188 were selected for increase and further evaluation in 2000 field trials. Sugar concentrations of the selected roots ranged form 12.2 to 18.5%. All selected roots have acceptable root size and shape. Some beets with sugar concentrations lower than desired were retained to provide a sufficient number of plants for the increase of a line. Depending on the outcome of the 2000 trials, we will either continue selecting within lines or will inter-pollinate lines with sugar concentrations very close to the concentrations observed in standard commercial hybrids.

Crosses of Miscellaneous wild *Beta* with Sugarbeet

The sugarbeet parent in these crosses was a California line (3747) segregating for genetic male sterility. Crosses were made on male sterile segregates. In subsequent intercrosses, seed was harvested from male sterile segregates to maintain the sterility and insure intercrossing. After two cycles of random intercrossing all populations were grown in a space planted nursery and selected for root shape. Lines that performed well in test crosses (L33cms) in 1996 were increased and evaluated again in replicated trials in 1997. Eleven of the 18 lines tested were increased in the summer of 1998. These were evaluated as lines in replicated trials in 1999 (Table 2). While progress has been achieved in obtaining a more desirable plant and root type, none of the lines have the sugar concentration needed for use in commercial programs. Nine of the eleven lines evaluated in 1999 are being increased in the greenhouse. These will be evaluated again in the field in 2000 and backcrossed to cultivated sugarbeet. F1010 (Campbell, 1990), F1012, or F1013, or F1014 (Campbell, 1992) probably will be used as the sugarbeet parents. These four sugarbeet germplasms have relatively high sugar concentrations and are not derived from the tradition commercial breeding pools.

Recent Introductions to the Breeding Program

Populations were formed by crossing a self incompatible sugarbeet line from California (R376-43) with thirty-seven wild *Beta* accessions from the United Kingdom, France, Ireland, Denmark, Belgium, and the Channel Islands. Ten plants from each wild accession were crossed (as pollinators)

Table 1. Performance of L53/PI 546420//L19 lines at Prosper, North Dakota, 1996 and Fargo, North Dakota, 1999.

Pedigree	Designation	1996 Individual Root Sugars Before Selection	1996 Individual Root Sugars Selected Roots	1999 Sugar	1999 Root Yield	1999 Recoverable Sugar	1999 Individual Root Sugars Before Selection	1999 Individual Root Sugars Selected For 2000
		%	%		tons / acre	lbs / acre	%	%
Y317 / L19	C-187**	15.1	16.0	14.0 a-g*	14.0 i-o	3068 fg	13.4	14.6
	C-189**	15.0	15.8	13.7 a-i	14.5 i-m	3181 e-g	13.3	14.3
	C-191**	15.1	15.7	14.2 a-f	12.2 l-o	2982 f-h	12.4	13.6
	C-193**	16.1	16.6	13.7 a-l	10.7 n-q	2253 g-j	14.2	14.8
	C-194**	16.1	16.6	14.6 ab	7.8 q	1709 ij	13.7	14.4
	C-195	14.4	15.3	12.9 g-l	15.5 g-m	3049 fg	----	----
	C-197	17.1	17.2	11.7 lm	13.0 k-o	2249 g-j	----	----
	C-200	16.0	16.1	12.6 i-m	16.6 f-k	3200 e-g	----	----
	C-201	15.4	16.0	13.2 d-k	11.8 m-q	2449 g-j	----	----
	C-202	15.4	15.8	12.4 j-m	10.4 n-q	2055 h-j	----	----
Mean	----	15.6	16.1	13.3	12.6	2620	13.4	14.3
Y318 / L19	C-203	15.2	15.5	13.4 b-h	14.0 i-o	2793 f-h	----	----
	C-204**	16.2	16.2	13.7 a-i	14.7 h-m	2950 f-h	13.5	14.0
	C-208**	16.1	16.6	13.7 a-i	12.8 k-o	2654 f-i	13.5	13.9
	C-211**	14.2	15.5	13.7 a-i	13.4 j-o	2825 f-h	14.1	15.0
Mean	----	15.4	16.0	13.6	13.7	2806	13.7	14.3
Y322 / L19	C-40	15.1	16.0	12.9 g-k	15.6 g-m	2974 f-h	----	----
	C-45**	15.3	15.9	13.4 b-j	15.6 g-m	3129 e-g	13.7	15.0
	C-62**	15.3	16.0	13.3 c-j	17.8 f-i	3545 d-f	13.0	13.5
	C-71**	16.2	16.9	13.8 a-i	16.5 f-l	3443 d-f	13.8	15.2
Mean	----	15.5	16.2	13.4	16.4	3273	13.5	14.6
Y387 / L19	C-76	15.0	15.4	12.0 k-m	19.3 e-g	3634 d-f	----	----
	C-78**	16.8	17.2	13.6 b-j	16.6 f-l	3548 d-f	13.7	15.0
	C-85	14.5	15.1	12.6 h-m	17.4 f-j	3150 e-f	----	----
	C-89**	15.3	15.5	13.0 g-k	15.2 g-m	2961 f-h	13.0	13.9
	C-92**	15.4	15.8	13.9 a-i	13.7 j-o	2902 f-h	13.5	14.7
	C-121	15.0	15.9	13.1 e-k	13.9 i-o	2702 f-h	----	----
Mean	----	15.3	15.8	13.0	16.0	3150	13.4	14.5
Mean all experimental lines		15.5	16.0	13.3	14.3	2892	----	----
Mean lines selected for 2000		----	----	13.7	14.0	2939	13.5	14.4
Parents	y317	----	----	13.1 g-k	11.9 m-p	2250 g-j	----	----
	y318	----	----	11.5 m	9.9 o-q	1642 j	----	----
	y322	----	----	13.4 b-j	19.0 e-n	4102 c-e	----	----
	y387	----	----	12.8 g-l	17.8 f-i	3616 d-f	----	----
Checks	AC-309	----	----	14.4 a-d	26.0 bc	5902 a	----	----
	B-3712	----	----	14.6 a-c	24.3 b-d	5679 a	----	----
	V-66156	----	----	13.5 b-j	26.7 b	5664 ab	----	----
	F1010	----	----	13.8 a-i	20.0 d-f	4228 cd	----	----

* Means within a column followed by the same letter are not significantly different; LSD 0.10.

** Indicated line was selected for further evaluation or as parental material for future crosses.

Table 2. Yield of "cultivated/wild" sugarbeet, Fargo, North Dakota, 1997 and 1999.

Pedigree	Designation	Sugar 1997	Sugar 1999	Root Yield 1997	Root Yield 1999	Recoverable Sugar 1997	Recoverable Sugar 1999	Recoverable Sugar 19997	Recoverable Sugar 1999
		%	%	T/A	T/A	LBS / T	LBS / T	LBS / A	LBS / A
3747 / B. maritima (Denmark)	C-19*	12.3	10.2	7.1	11.7	210	143	1538	1704
3747 / B. maritima (Belgium)	C-22*	12.3	10.8	7.5	9.5	208	160	1558	1542
	C-153	11.3	9.4	7.8	6.4	185	122	1365	800
3747 / B. maritima (Ireland)	C-27*	12.0	10.7	10.5	10.8	208	156	2200	1700
	C-24*	10.9	11.0	10.5	10.9	180	167	1846	1811
3747 / B. maritima (Middle East)	C-145*	11.2	9.7	11.5	11.7	189	144	2170	1670
3747 / B. Atriplicifolia	C-180*	12.1	10.9	11.4	12.6	205	156	2327	2058
	C-165	11.7	9.4	10.1	6.7	197	131	1933	892
	C-141*	11.0	10.5	11.3	10.7	172	148	1804	1624
3747 / B. macrocarpa	C-29*	10.6	9.7	10.2	11.4	176	136	1789	1583
3747 / B. patula	C-143*	10.9	10.6	12.9	11.1	174	160	2206	1785
F1010	----	14.2	12.5	9.1	12.0	253	203	2312	2463
VDH - 66140	----	13.7	12.2	15.3	13.9	246	196	3755	2709
ACH-102	----	12.5	11.1	15.7	15.7	210	162	3390	2520
Mean	----	11.5	10.7	10.3	11.6	192	159	1997	1876
LSD (0.10)	----	1.2	1.0	3.2	3.5	32	26	645	742

* Indicates line was selected for further evaluation or as parental material for future crosses.

individually to R376-43. Ten F_1 plants from each cross (100 plants) were intercrossed to produce the F_2 generation. Equal numbers of seeds from each F_2 plant were grown and intercrossed to produce the F_3 seed. Selection for root shape was initiated with the 1998 crop. Selected plants were increased in the greenhouse to produce seed for a second cycle of selection for root shape in 1999. Plants selected in 1999 will be increased in the greenhouse and subjected to a third cycle of mass selection for desirable plant and root characteristics. Reducing the frequency of plants with multiple crowns may be as difficult as obtaining an acceptable root shape.

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IDENTIFICATION OF SUCROSE METABOLIZING ENZYMES RESPONSIBLE FOR SUCROSE LOSSES DURING SUGARBEET DEVELOPMENT AND STORAGE

BSDF Project 650

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Three enzymes are responsible for nearly all sucrose degradation in sugarbeet. Acid invertase, alkaline invertase and sucrose synthase degrade sucrose to the metabolically active hexose sugars. Invertases catalyze the hydrolysis of sucrose to produce the two invert sugars, glucose and fructose. Invertases are categorized into two groups based on their pH optimum for activity (Tymowska & Kreis, 1998). Acid invertases are most active at pH 4.5 to 5.5, and occur as soluble isoenzymes located in the cell vacuole or insolubilized in the cell wall. Alkaline invertases are most active at pH 7.0 to 8.0 and are located in the cell cytoplasm. The function of invertases is presently unclear, although it has been suggested that acid invertase is detrimental to sucrose accumulation during root development and may be involved in storage losses (Berghall *et al.*; 1997, Wyse, 1974). No functions are known for alkaline invertase. Sucrose synthase is the other major sucrose degrading enzyme in sugarbeet roots. Sucrose synthase catalyzes the cleavage of sucrose using uridine diphosphate (UDP) to form UDP-glucose and fructose in a reversible reaction. Like alkaline invertase, this enzyme is found in the cell cytoplasm. While its function in sugarbeet is unknown, there is evidence from other plant species that sucrose synthase activity is important for sucrose transport and carbohydrate accumulation in storage organs (Zrenner *et al.*, 1995).

Understanding the role of these enzymes in sucrose losses during root development and postharvest storage has proven difficult due to the nature of the enzymes involved. All the major sucrose degrading enzymes exist not as single enzymes, but as families of related isoenzymes. Although isoenzymes are broadly similar in their reactivities, they are typically expressed at different stages of development, have different biochemical properties and are likely to perform different roles in the plant. To better understand the role of the major sucrose degrading enzyme activities in sucrose losses in sugarbeet roots, a study of the activity of individual sucrose degrading isoenzymes was initiated. Specifically, this research has sought to determine the number of isoenzymes of the major sucrose degrading enzymes in sugarbeet roots and their relative contribution to sucrose degradation during root development and postharvest storage.

Methods

Sugarbeet hybrid H66156 (Van der Have) was used in all studies except for the respiration study of field grown sugarbeet roots in which the sugarbeet hybrid 9363 (Maribo) was used. For the developmental study, plants were greenhouse grown with supplemental lighting and 16 hr days. For postharvest study, field grown roots were harvested 120 days after planting, washed and stored at 6, 12 or 21°C and 95% relative humidity. Ten replicate roots were collected for each sample. Soluble proteins were extracted from root samples by homogenization of lyophilized tissue in extraction buffer (100 mM HEPES-NaOH, pH 7.2, 10 mM Na_2SO_3, 5 mM DTT and 1mM $MgCl_2$) and centrifugation to remove cell debris. Crude extracts were dialyzed overnight against 10 mM

HEPES-NaOH, pH 7.2, 1 mM DTT and 1 mM $MgCl_2$ to remove sugars. The protein extracts were assayed for acid and alkaline invertase activity by the method of Goldstein and Lampen (1975) at pH 4.7 and 8.0 for acid and alkaline invertase, respectively. Sucrose synthase activity was measured in the direction of sucrose breakdown by the reducing sugar assay of Somogyi (1952). Insoluble acid invertase activity was measured in protein extracts from the cell wall or by direct assay of the cell wall pellet. For extracted cell wall proteins, the pellet of cell debris was washed twice with extraction buffer, extracted overnight with cell wall extraction buffer (100 mM HEPES-NaOH, pH 7.2, 10 mM Na_2SO_3, 5 mM DTT, 2 M NaCl and15 mM EGTA), centrifuged to remove cell debris and dialyzed overnight. Cell wall invertase activity was assayed as described above for soluble acid invertase.

The presence of isoenzymes for each enzyme family was determined by activity staining of isoelectric focused polyacrylamide gels with ampholines in the pH range of 3.5 to 9.5. Focused gels were incubated for 30 minutes in substrate and stained with 0.1% (w/v) 2,3,5-triphenyltetrazolium chloride (Gabriel and Wang, 1969). Substrates used were 100 mM sucrose for invertase activity and 100 mM sucrose and 10 mM uridine diphosphate for sucrose synthase activity. Acid invertase, alkaline invertase and sucrose synthase activities were assayed at pH 4.7, 7.8 and 6.5, respectively. Control gels were incubated in the appropriate buffer without substrate and stained as above.

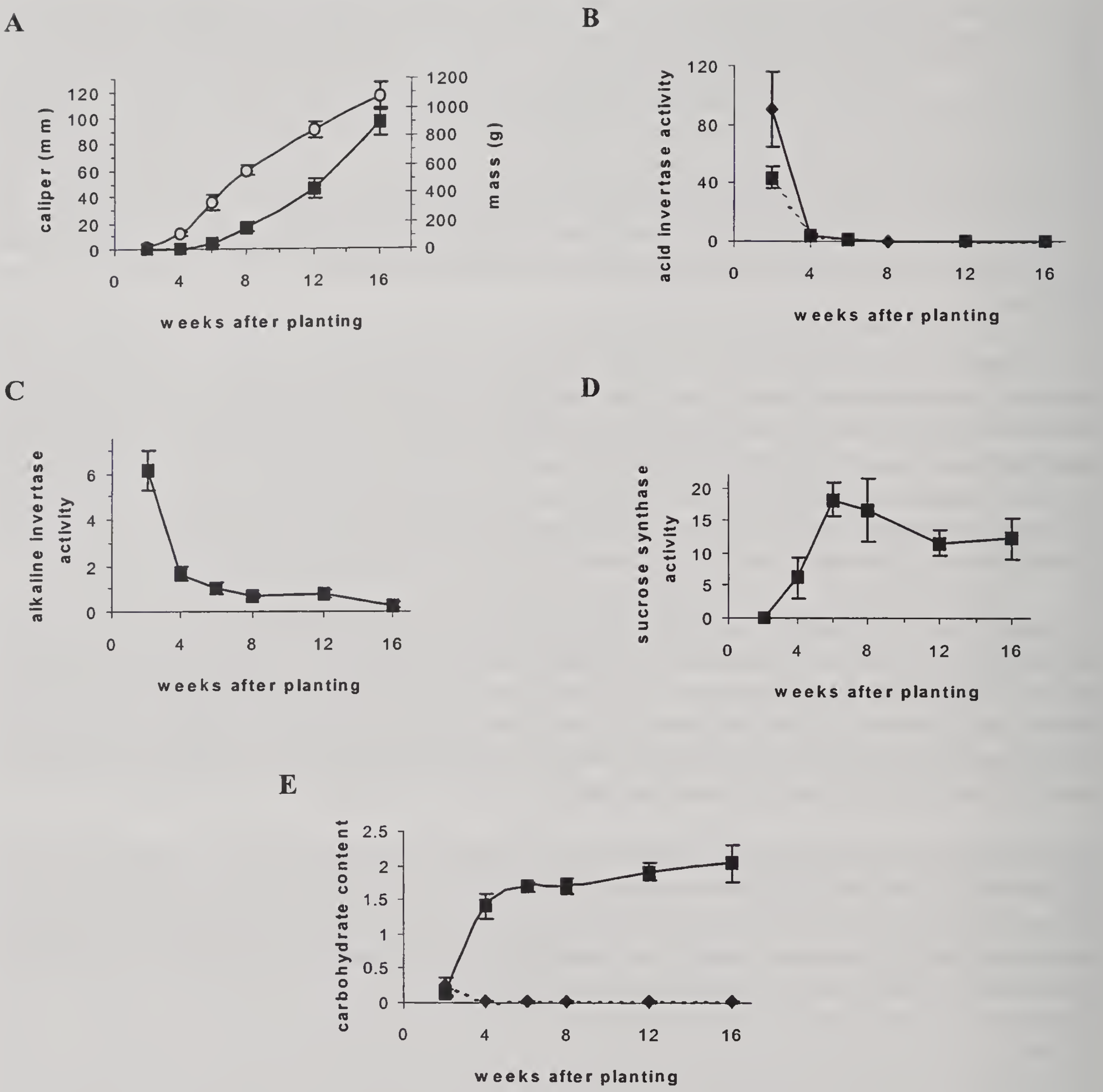
Sucrose, glucose and fructose contents were determined by HPAE-PAD using lactose as an internal standard. Soluble carbohydrates were extracted twice with refluxing 80% EtOH. After evaporation of EtOH, the extract was passed over a bed of C_{18} and eluted with H_2O. The eluate was filtered through a 0.22 µm nylon filter and injected onto a Dionex CarboPak PA-10 column. Carbohydrates were eluted isocratically with 60 mM NaOH at 1.0 ml/min and detected with an electrochemical detector operating in pulsed amperometric mode.

Respiration was measured by placing six to eight roots of known weight into a sealed six gallon bucket with a continuous air flow of 350 ml min^{-1}. After 24 hr, the CO_2 exiting the bucket was measured using an infrared CO_2 analyzer. Respiration was corrected for background CO_2 levels by measuring the CO_2 exiting an empty bucket and corrected for standard temperature and pressure. Three replicate buckets were measured for each data point.

Results

Developmental Study

The relative contribution of acid invertase, alkaline invertase and sucrose synthase to the total sucrose degrading activity of sugarbeet roots changes with root development. Similarly, the contribution of individual isoenzymes of these enzyme activities to sucrose degradation also changes with development. Figure 1 shows the change in total activity for the three major sucrose degrading activities of sugarbeet roots during development in relation to root size and carbohydrate accumulation. In young roots, the invertases are the predominant sucrose degrading activities. Soluble acid invertase, cell wall acid invertase and alkaline invertase were all at their highest levels in two week old seedlings. The greatest sucrose degrading activity in seedling roots, however, was soluble acid invertase. Only one isoenzyme was responsible for this activity. Its activity was more than double the activity of extractable cell wall acid invertase activity and nearly fifteen times greater



A. Change in root caliper, measured at widest portion of root (— o —) and mass of whole root (— ■ —).
B. Change in soluble acid invertase activity (— ◆ —) and extractable cell wall acid invertase (····■····).
C. Change in alkaline invertase activity.
D. Change in sucrose synthase activity.
E. Change in sucrose content (— ■ —) and reducing sugars (···· ◆ ····). Reducing sugars is combined concentration of glucose and fructose.

Figure 1: Change in root size, acid invertase activity, alkaline invertase activity, sucrose synthase activity and carbohydrate content during sugarbeet root development. Activity for all enzymes is expressed as μmol sucrose mg protein^{-1} hr^{-1}. Carbohydrates are expressed as mmole g dry wt^{-1}.

than the activity of alkaline invertase. Beyond the two-week stage, invertase activity declined precipitously. Both soluble and extractable cell wall acid invertase activities declined 22- and 12-fold, respectively, between two and four weeks after planting, and by six weeks, their activities were barely detectable. Alkaline invertase activity decreased slightly between two and four weeks and was present at low, relatively constant levels throughout subsequent sugarbeet root development. Two alkaline invertase isoenzymes with isoelectric points of 5.3 and 5.9 contributed to this activity. Although both isoenzymes were present throughout root development, their relative contribution to total activity changed with age. As sugarbeet roots matured, the contribution of the more anionic of these two isoenzymes to total alkaline invertase activity increased, while the activity of the more cationic isoenzyme decreased. Sucrose synthase was the predominant sucrose degrading enzyme during all but the earliest stages of growth and accounted for nearly all sucrolytic activity in mature sugarbeet roots. Sucrose synthase activity increased during the first six weeks of growth and remained at high levels for the remainder of the growing period. Two sucrose synthase isoenzymes contributed to sucrose synthase activity. Only one isoenzyme was evident in roots during the first twelve weeks of growth. Two isoenzymes were present by sixteen weeks.

Postharvest Study

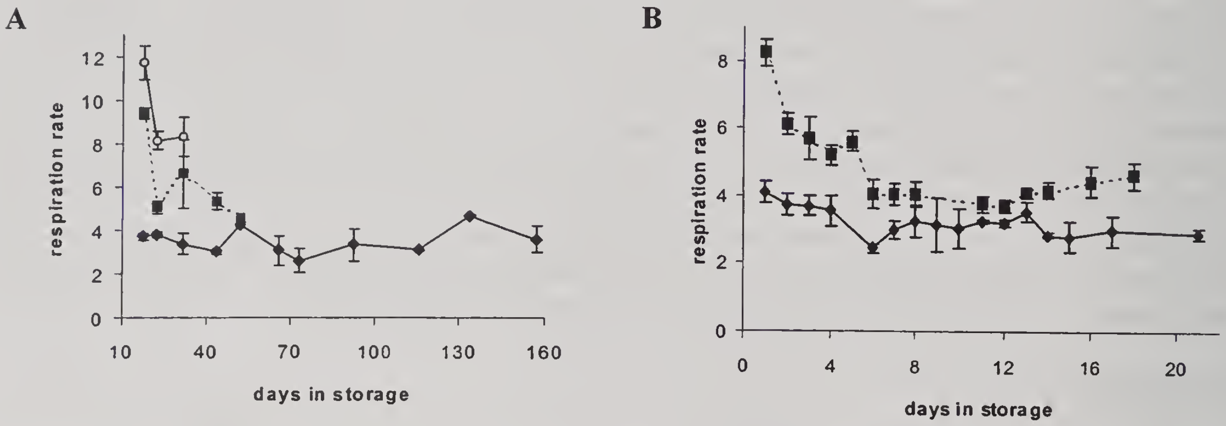
The change in sucrose degrading enzymes during storage under favorable and unfavorable conditions is ongoing. Change in total enzyme activity and isoenzyme levels are being measured in field grown sugarbeet roots stored at 6, 12 and 21° C. Although studies are not complete, initial results suggest only minor changes in total acid invertase, alkaline invertase and sucrose synthase activities during storage. Sucrose synthase remains the major sucrose degrading enzyme throughout storage. Soluble acid invertase, cell wall acid invertase and alkaline invertase are present at low levels even after prolonged storage or storage at elevated temperatures.

The respiration of sugarbeet roots at three different storage temperatures was also measured (Figure 2). Respiration is thought to account for 50 to 70% of sucrose losses in storage (Wyse & Dexter, 1971). Respiration of field grown roots and greenhouse grown roots were measured at 6, 12 and 21° C, and 6 and 13° C, respectively. Respiration rate over time in storage was biphasic. The initial phase, occurring in the first seven to fourteen days after harvest, was characterized by a nearly linear decline in sugarbeet root respiration. The duration of this stage was shorter for greenhouse grown sugarbeet roots (Figure 2B) than for field grown roots (Figure 2A) and probably reflects the gentler harvest and handling conditions these roots received. After the initial period of declining respiration rate, a second phase of respiration was observed during which sugarbeet root respiration remained relatively constant, even after prolonged storage. Root respiration rate during this phase was dependent on storage temperature.

Discussion

Different sucrose degrading enzymes are important at different developmental stages. In young roots, the invertases, especially the acid invertases, are the predominant sucrolytic enzymes. Their contribution to the total sucrose degrading activity in roots, however, is minimal after six weeks of growth. By six weeks, sucrose synthase is the major sucrose degrading activity and remains the major sucrose degrading activity in all subsequent stages of development. It is during this period, when sucrose synthase is most active, that sucrose accumulation in the root is greatest. Sucrose losses during this period, therefore, are most likely to occur by the action of one or more sucrose

synthase isoenzymes. Sucrose synthase also appears to be the major sucrose degrading enzyme during postharvest storage, although these studies are not yet complete. It most certainly is the predominant sucrolytic enzyme in the first two weeks after harvest when root respiration is greatest.



A. Respiration of field grown sugarbeet roots stored at 6°C (—◆—), 12°C (···■···) and 21° C (—O—).
B. Respiration of greenhouse grown sugarbeet roots stored at 6°C (—◆—) and 13° C (···■···).

Figure 2: Respiration rate (ml CO_2 kg^{-1} hr^{-1}) of sugarbeet roots stored at different temperatures.

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SUGAR BEET RESEARCH

1999 REPORT

Section E

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<u>CONTENTS</u>

I. Sugar beet activities of the USDA-ARS East Lansing conducted in cooperation with Saginaw Valley Bean and Beet Farm during 1999.

The USDA-ARS conducted four trials at the Saginaw Valley Bean and Beet Research Farm, Saginaw, MI in 1999. Two of the trails used the same accessions in different locations for seedling disease evaluation (Tests 9911BB and 9913BB, reported together). Two other trials were the standard agronomic test (9912BB, reported here), and a *Cercospora* trial planted alongside of the Michigan and Monitor Sugar Cos. *Cercospora* variety evaluation (not reported here).

The 1999 sugarbeet field trials were planted in Range 9, tiers 7 through 10. This land had been in corn in 1999. The soil was prepared by fall plowing, followed by frost tillage in the early spring. Beets were planted on April 29, 1999. Pre-emergence herbicide (3 qt. Pyramin and 2 qt. Nortron SC per acre) was banded onto the rows immediately following seeding. Seed germination was good overall.. Plots were thinned to 6 to 8" between plants within the row and weeded by the second week of July, resulting in good plant stands after thinning and weed control. All experiments were machine harvested October 5, 1999. Sugar analysis was generously provided by the Michigan Sugar Co. sugar laboratory and their assistance is greatly appreciated. All statistical analyses were performed with the aid of MSTAT and / or JMP (SAS Institute). *Cercospora* was controlled with applications of Benylate, Super Tin, and / or Manzate.

TESTS 9911BB AND 9913BB: FIELD EVALUATION OF EMERGENCE UNDER SEEDLING DISEASE PRESSURE

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The objective of this test was to examine field emergence in a range of *Beta* germplasm to evaluate for early resistance to seedling diseases. 114 entries were drawn from germplasm held in the USDA National Germplasm System, and an additional 11 from recent East Lansing releases (Table 1). Generally, the Plant Introduction (PI) accessions were chosen from geographic regions of collection, reasoning was that accessions from warmer and drier areas may show either better tolerance of abiotic stress (including water stress early in the season) or to higher temperature seedling diseases such as *Aphanomyces* and *Rhizoctonia*. Due to limited seed quantities of the PIs, only a single replication of 150 seeds was evaluated in each of two treatments (e.g. 9911BB and 9913BB). Approximately 200 seeds from the seed received are currently available for re-testing. ACH 555 was used as an external check.

Test 9913BB was planted in the south half of Range 7, tiers 11-12. These plots have a history of poor beet growth, presumably due to high seedling disease pressure. All major groups of seedling disease fungi were isolated here in 1999, with *Pythium* being particularly prevalent (John Halloin, pers. comm.).

Emergence counts were taken five times between the time of first emergence on May 12 until June 10. Each plot was planted with 150 seeds as received from the GRIN system. Stands were not thinned, nor was yield data taken. Emergence data was analyzed prior to selections for further evaluation. Selections were based on a number of criteria, including (i) high stand persistence relative to maximal emergence in both tests, (ii) high persistence in 9911BB (e.g.

good ground) and 9913BB (e.g. disease plots), and (iii) final stand evaluations in September 1999. Accessions with reasonable emergence scores but showing severe *Rhizoctonia* damage were excluded from selections at this time, as were accessions that flowered during the season. 23 lines were selected from 9913BB for crossing in the 2000 greenhouse (Table 1).

Results : This test was conducted to determine the feasibility of seedling disease resistance testing by comparing within and between diseased and non-diseased plots at the B&B Farm. As a first approximation, the test was successful for 1999 and it appears that tests like this may serve as a first screening to identify potential germplasm sources to combat seedling diseases. Emergence counts are not presented here, but will be made available on request. Thus, this report presents an overview of the trials.

Excellent stands were obtained in 9911BB (good ground) for all but one accession (PI 558505), but stands were variable in 9913BB (diseased ground) and mortality was higher. Growth throughout the season of all accessions was also superior in 9911BB vs. 9913BB, although precise measurements were not taken for relative growth rates nor biomass accumulation. Some accessions showed greater emergence values in 9913BB relative to 9911BB, but this was likely due to greater moisture availability in 9913BB during the early part of the season since these plots are slightly lower in elevation than 9911BB.

Stand loss was observed in all plots of both 9911BB and 9913BB. In most cases, half of the seedlings counted at maximum emergence were present by the last count in 9911BB, and perhaps slightly fewer in 9913BB. The lack of persistence presented problems with interpreting emergence data, since no clear persisting PIs were evident by the fifth count even in the good ground. By the fifth count, almost without exception, accession counts were lower in the disease plot than the non-disease plot.

All accessions were described as cultivated biennial types in the GRIN system, but 24 of the 125 lines flowered under conditions at the Bean and Beet Farm in 1999. These annual types were rogued as soon as possible after flowering. At least one of the annual types (PI 163176) showed promising emergence results from the analyses. This accession will need to be re-evaluated since no plants were brought back for crossing.

In general, Eastern US Germplasm performed among the best as a group. Their stands were more uniform than any other group. ACH 555 showed similar performance. However, in the disease test, plant size was markedly reduced suggesting that the continuous disease pressure was detrimental for not only emergence but also subsequent growth and development.

One exceptional accession was evident in the disease test group, PI 590770, which turned out to be SP85303. SP85303 was developed by G. Coe of the USDA-ARS at Beltsville and is among the most resistant *Aphanomyces* selections developed by him. In the 1992 Bean and Beet Farm Report, SP85303 (reported as 88EL303) had reasonable performance in a standard agronomic test with 16.89% sucrose and 21.8 tons per acre. Although weights were not taken from the 1999 disease plot, the SP85303 beets harvested were superior in size, lack of disease lesions, and relative weight compared with all other selections.

Table 1: Accessions tested for field emergence under seedling disease pressure. Asterisks indicate an accession that behaved as an annual, bold indicates lines selected.

ID	ITEM	ORIGIN	TYPE	ID	ITEM	ORIGIN	TYPE
Ames 2684	Ames 2684	nd	nd	PI 174063	KOCABAS	Turkey	FODDER
Ames 3062	Ames 3062	Denmark	nd	*PI 175047	PALAK	India	LEAF
Ames 8288	B180	UK	nd	**PI 175594**	No. 5973	Turkey	SUGAR
Ames 8289	B182	UK	nd	PI 175597	KOCABAS	Turkey	FODDER
Ames 8294	B197	UK	nd	PI 175598	KOCABAS	Turkey	FODDER
PI 109040	No. T-169	Turkey	FODDER	PI 175599	KOCABAS	Turkey	SUGAR
PI 117116	No. 296	Turkey	FODDER	PI 175600	KARACA OREN	Turkey	FODDER
PI 117117	No. 299	Turkey	SUGAR	PI 175601	PAZI	Turkey	SUGAR
PI 120282		Turkey	FODDER	PI 176423	KOCABAS	Turkey	SUGAR
PI 120689	No. 1219	Turkey	FODDER	PI 176424	PAZI	Turkey	SUGAR
PI 120695	No. 1814	Turkey	FODDER	PI 176425	No. 8972	Turkey	nd
*PI 120696	No. 2124	Turkey	SUGAR	**PI 176426**	KOCABAS	Turkey	FODDER
PI 120704	No. 3170	Turkey	FODDER	PI 177273	No. 6361	Turkey	FODDER
PI 120705	No. 3208	Turkey	SUGAR	PI 177274	No. 9763	Syria	TABLE
PI 120707	No. 3264	Turkey	FODDER	PI 177275	BELEDI	Turkey	TABLE
PI 124528	CHAKUNDA	India	TABLE	PI 178837	PAZI	Turkey	FODDER
PI 140357	No. 6820	Iran	FODDER	PI 179173	No. 5016	Turkey	SUGAR
*PI 163176	PALOG	India	LEAF	*PI 179179	CICLA	Turkey	FODDER
PI 163178	CHOGHUNDUR	India	TABLE	*PI 181011	No. 8563	India	LEAF
PI 163179	CHOGHUNDUR	India	TABLE	PI 181859	CICLA	Syria	TABLE
PI 163182	CHOGHUNDUR	India	TABLE	PI 181930	Homs No. 30	Syria	TABLE
PI 164292	No. 8928	India	TABLE	PI 181931	CICLA	Syria	LEAF
PI 164659	No. 9084	India	TABLE	PI 204677	No. 174	Turkey	FODDER
*PI 164747	SAG	India	LEAF	PI 204678	No. 178	Turkey	FODDER
PI 164805	CHOGHUNDAR	India	TABLE	*PI 206407	No. 694	Turkey	FODDER
*PI 164806	PALAK	India	LEAF	*PI 212883	PALAK	India	FODDER
PI 164810	No. 9240	India	LEAF	*PI 212884	PALAK	India	LEAF
PI 164968	No. 44	Turkey	TABLE	*PI 215577	No. 13676	India	FODDER
PI 165013	HAYVAN PAU.	Turkey	SUGAR	*PI 217964	RALEK	Pakistan	LEAF
PI 165037	No. 113	Turkey	FODDER	*PI 264150	INDIA	India	LEAF
*PI 165502	PALAK	India	LEAF	*PI 269871	No. 421	Pakistan	LEAF
PI 169014	No. 1394	Turkey	SUGAR	*PI 269872	No. 507	Pakistan	LEAF
PI 169015	No. 1423	Turkey	TABLE	**PI 269873**	CHINA	Pakistan	SUGAR
PI 169016	PAZI	Turkey	SUGAR	*PI 269874	No. 698	Pakistan	LEAF
PI 169018	PANCAR	Turkey	SUGAR	PI 269875	No. 920	Pakistan	SUGAR
PI 169019	No. 1844	Turkey	TABLE	*PI 271438	PALAK	India	LEAF
PI 169020	PAZI	Turkey	SUGAR	PI 271439	1189	India	TABLE
PI 169023	No. 2246	Turkey	TABLE	*PI 271440	1276	India	LEAF
PI 169024	KIRMIZI	Turkey	SUGAR	*PI 271441	1286	India	LEAF
PI 169025	No. 2693	Turkey	SUGAR	*PI 275637	1349	India	LEAF
PI 169027	No. 2952	Turkey	FODDER	*PI 277270	BANERJEE'S GIANT	India	LEAF
PI 169028	No. 2960	Turkey	TABLE	**PI 285589**	EPIPSKI FREEGE	Poland	TABLE

Table 1 (con't): Accessions tested for field emergence under seedling disease pressure.

ID	ITEM	ORIGIN	TYPE	ID	ITEM	ORIGIN	TYPE
PI 169029	PANCAR	Turkey	TABLE	PI 285590	EPIPSKI HOSER	Poland	TABLE
PI 169030	No. 3395	Turkey	TABLE	PI 285591	OKRAGLY CIEMNOCZ.	Poland	TABLE
PI 171509	HAYVAN	Turkey	FODDER	PI 285592	CRASSA STRZELECKI.	Poland	SUGAR
PI 171512	No. 6864	Turkey	FODDER	**PI 285593**	CRASSA UDYCKI ZOL.	Poland	SUGAR
PI 171513	No. 6883	Turkey	FODDER	PI 285594	CRASSA WALCOWAT.	Poland	SUGAR
PI 171516	No. 7154	Turkey	FODDER	PI 285595	CRASSA WALCOWAT.	Poland	SUGAR
PI 171517	No. 7159	Turkey	SUGAR	PI 293419	PODZIMNIAJA 0474	F. USSR	TABLE
PI 171518	No. 7164	Turkey	FODDER	PI 357357	OKRUGLA	Macedonia	RED
PI 172730	No. 7425	Turkey	FODDER	**PI 357360**	Ohridska Zolta	Macedonia	RED
PI 172740	KOCABAS	Turkey	FODDER	**PI 357366**	Zolta	Macedonia	LEAF
PI 172741	No. 8490	Turkey	LEAF	*PI 408965	Pusa Jyoti	India	nd
PI 173842	CHOGHUNDAR	India	TABLE	PI 546390	WB 69	US	WILD
*PI 173843	PILAK	India	LEAF	PI 546411	Ames 4218	UK	WILD
PI 173844	CHOGHUNDAR	India	TABLE	PI 558505	FC 506	US	SUGAR
PI 174058	No. 7764	Turkey	FODDER	PI 558515	FC 403	US	SUGAR
EASTERN US GERMPLASM							
PI 590770	SP85303-0	US	SUGAR		SR80	US	SUGAR
	98EL02	US	SUGAR		SR87	US	SUGAR
	98EL04	US	SUGAR		SR93	US	SUGAR
	EL38	US	SUGAR		SR94	US	SUGAR
	EL48	US	SUGAR		SR95	US	SUGAR
	EL50	US	SUGAR		EL51	US	SUGAR

Figure 1: Relative performance of accessions between plots.

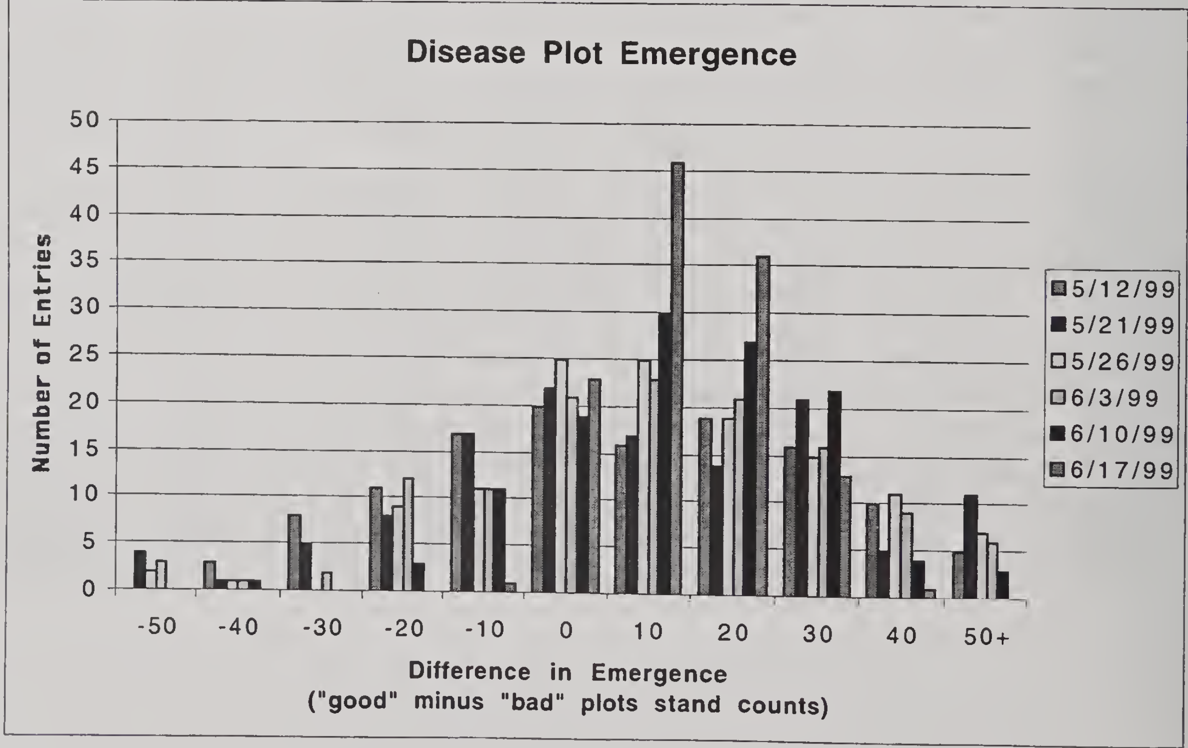

Figure 1 presents the relative performance of accessions in both the "good" non-diseased plots (9911BB) and the "bad" disease plots (9913BB) for each of the six counting dates. Each plot had the same number of seeds planted. Most accessions performed better in the non-diseased plots (e.g. a difference in emergence > 0). Accessions with scores <0 were seen, but their significance is unclear at this point. Of particular interest are the accessions with little or no differences between plots, as these are fairly numerous in number and may present sources of genes that appear to perform with less environmental dependence, including disease pressure, than others.

In total, we were encouraged by the results form comparing emergence and persistence in diseased and non-diseased plots. However, the interpretation of these results must be qualified. First, direct comparison is not possible due to differences in the speed of emergence (or other developmental processes), likely due to available moisture supply. Second, screening in the disease nursery identified accessions that performed better or worse under disease conditions, but the problem of stand persistence in good ground appears not to have been addressed by these comparisons. Third, because PIs differ markedly in the genetic structure of their populations, it is possible that effective and desirable seedling resistance genes are present at low frequency among the survivors. It is apparent that at least some of these genes are present at high frequency in accessions from the Eastern US germplasm pool. And finally, perhaps the most apparent operational criteria for selection is equivalent performance in diseased and non-diseased plots. In general, those accessions that we selected showed more similarities in performance between good and disease plots, suggesting that their performance might be expected to be more consistent across a range of environments.

EXPERIMENT 9912BB: AGRONOMIC EVALUATION OF SMOOTH ROOT RELEASES AND PROSPECTIVE RELEASES – 1999

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This experiment was designed to evaluate performance of 24 entries for the standard agronomic parameters, and smoothroot score as a surrogate measure for low soil tare. We considered this test reliable and well executed and in line with past performances of those entries tested in prior years. Three commercial hybrid varieties (ACH 185, Betaseed 5931, Novartis E17) and two popular hybrids from the 1970s and 1980s (US H20 and US H23) provided performance references.

Three East Lansing releases were included; a West Coast Beet Seed increase of the 1971 release monogerm O-type EL38, 1997 smoothroot release SR94, and 1998 smoothroot release SR95. Five were of the planned smoothroot releases SR96, 94HS25, monogerm multiple disease resistant 99J19-00, monogerm 99J31-00 and monogerm 99J33-00. Two others were 98EL02 and 98EL04 scheduled for release combining parentage and selection for smoothroot, higher sucrose, and the Holly monogenic Rhizomania resistance. Three lines (98J24-01, 98J34-01, and 98J41-01) have common background from hybridizing high sucrose, smoothroot germplasm with Hogaboam era monogerm germplasm containing significant levels of Rhizoctonia resistance plus high levels of Cercospora and Aphanomyces resistance. The list of entries is rounded out by five lines derived entirely or at least 50% from population 95H07, itself a cross of an EL50 root with a selected smooth root beet. Prospective release 99J19-00 is also derived predominantly from 95H07. Also included in this test was an experimental smooth root line from a seed company (97-060515-01).

For ease of reference, these groupings of entries are listed below:

- 5 are released hybrids,
- 1 is an experimental hybrid,
- 3 are past EL releases,
- 5 are prospective smoothroot EL releases,
- 2 are planned smoothroot EL releases with Rhizomania resistance,
- 3 are lines with high sucrose smoothroot and Hogaboam era Rhizoctonia resistance ancestry,
- 5 are 95H07 derivatives (6 including 99J19-00).

A more condensed grouping helpful in interpreting performances is:

- 4 are modern hybrids,
- 7 are entries with traditional rough exteriors,
- 17 are smoothroot entries,
- 3 are entries without Theurer era high sucrose percent ancestry,
- 4 are past or planned SR releases with moderately high sucrose percent,
- 5 are monogerm lines of three different ancestries.

Performance is ranked by recoverable white sugar per acre (RWSA) in Table 1. A conspicuous grouping in the top five entries for RWSA is seen with the East Lansing germplasms SR95, SR96, and SR94, with the remaining two of the top five modern hybrids. Interestingly, SR95,

SR96, and SR94 (RWSA mean of 7312 lbs. / A) each have a diverse ancestry. All four modern hybrids (RWSA mean of 6826 lbs. / A) are ranked in the top half of the entries. The lowest RWSA was O-type EL38, a 1971 Hogaboam self-sterile release likely based on several clones. Next lowest in ranking is 98J24-01, which appears to be at least an S_2 generation family, derived from an unrecognized self-fertile beet selected for smoothroot and high sucrose percent by Clair Theurer at East Lansing (prior to his retirement).

Beet yield by tonnage per acre is not ordered in Table 1, but some patterns are evident. Ranks 1 and 6 of the 24 in the test are held by derivatives of population 95H07. The top rank is held by 98J02x05, a pair cross of two smoothroot selections from 95H07, and the #6 rank is held by 99J19-00, a close relative of 98J02x05. 99J19-00 is closely derived from 98J19-01, which topped the tonnage per acre ranking among fifteen entries in a test at the Saginaw Valley Farm in 1998. (Overall, in the two 1998 tests at the Saginaw Valley Farm, 3 of the top 5 entries for tonnage were 95H07 derivatives.) EL38 is ranked least in tonnage, being somewhat of an inbred. The next to last tonnage ranking belongs to the top sucrose entry 98J24-01, discussed above as an inbred line and seen in the field as a smaller canopy entry.

Sucrose percentage by entry ranged from 18.23 to 15.41, with the three modern commercial hybrid cultivar checks averaging 18.00%. Top ranking was held by the moderately smoothroot 98J24-01 with 18.23%. The spread of 2.8 % points between the lowest entries and the modern commercial checks is similar to that from most other years with full season growth. One grouping of entries by sucrose percent consistent with past years is the "traditional East Lansing germplasm" trio of 98J02x05, 99J19-00, and 99J02-00 with a mean of 15.52 (range was 15.41-15.64). Other East Lansing breeding lines and releases with various proportions of high sucrose percent parentage had a continuum of sucrose concentrations above 16%.

Clear juice purity (CJP%) rankings were topped by modern commercial hybrid Novartis E17 (93.88%), with three (mean = 93.67%) of the four top spots held by three of the four modern hybrids. The six lowest purities were held by the group of various 95H07 derivatives (mean = 91.92%), a pattern also seen with that germplasm in 1998.

Amino N rankings had groupings including both members of the closely related pair (mean = 9.80) of monogerm smoothroot lines 99J31-00 and 99J33-00, ranked 2nd and 4th best, respectively. Overall, test range was 9.26 - 17.57. Mean of the three modern commercial checks was 10.57 (range was 9.26 - 11.82). The six members of the 95H07 derivative group ranked in the worst third of the rankings. Amino N of EL38 ranked 21st, but in retrospect, this may have been due to its poor stand and intrinsic low vigor. Adjustments to tonnage per acre can be figured from pre-harvest stand and gap measurements, but these same adjustments can't be (easily) used to adjust amino N. Poor stand differentially makes more nitrogen available to the beets that are there, delaying the idealized late season transition from nitrogen luxury to nitrogen paucity.

Smoothroot (SR) score rankings showed seven "traditional" sugarbeet entries (the four modern hybrids, plus US H20, US H23, and EL38) bunched at the highest values (i.e. the deepest sutures). Mean of the seven was 2.17, and the range 2.04 - 2.25. The smoothest entries scored 1.50 - 1.60, including SR95, SR96, and prospective releases 94HS25, 99J19-00 and 99J31-00. SR95 was considered the smoothest line entered in the test, from prior years' scores.

The properties of the nine breeding germplasm entries, agronomically evaluated for the first time here, indicate the recent emphasis of the sugarbeet breeding program at East Lansing. All nine

new entries are high to moderate for smoothroot as well as for resistance to *Cercospora* and *Aphanomyces* Four of the nine are monogerm with enhanced CMS-maintainer frequency, moderate *Rhizoctonia* resistance, and/or improved sucrose percent, depending on the entry. The other five new entries carry deliberately introduced recessive alleles for monogerm or CMS-maintenance that can be recovered in fixed form in current or future generations. Emphasis on disease resistance and higher sucrose percentage will continue and complement the easily selectable smoothroot characteristic.

Table 1 : Agronomic performance of lines in Test 9912BB.

Entry	RWSA	RWST	Tons/Acre	Sucrose%	CJP %	Amino N	SR score
SR95	7465.6	240.8	31.03	16.98	93.28	12.56	1.54
97-060515-01	7407.0	245.9	30.12	17.25	93.44	9.72	2.21
SR96	7330.6	247.6	29.60	17.53	93.01	13.59	1.50
Betaseed 5931	7201.5	260.1	27.68	18.09	93.68	10.62	2.17
SR94	7142.6	243.4	29.36	17.12	93.37	11.26	1.75
98J34-01	7056.8	234.9	30.03	16.95	92.26	15.41	1.88
98EL04	6961.1	223.3	31.20	16.09	92.51	12.68	1.71
98J02X05	6916.2	212.4	32.62	15.64	91.70	14.23	1.58
98J27-00	6428.2	225.9	28.54	16.41	92.08	16.48	1.63
Novartis E17	6420.9	255.6	25.10	17.73	93.88	9.26	2.21
98J41-01	6329.7	246.1	25.71	17.45	92.94	10.70	1.75
ACH 185	6277.0	254.1	24.67	18.18	92.44	11.82	2.21
99J19-00	6243.4	210.0	29.73	15.51	91.60	17.57	1.50
94HS25	6167.3	240.6	25.59	17.21	92.64	12.30	1.54
99J02-00	6104.5	210.8	28.99	15.41	92.08	14.64	1.75
98EL02	6041.3	226.8	26.49	16.08	93.21	12.85	1.75
97J27-00	6009.9	226.8	26.51	16.51	91.99	13.87	1.50
US H23	5999.1	227.1	26.39	16.46	92.17	13.28	2.13
98J28-02	5867.8	223.5	26.20	16.25	92.08	14.19	1.83
99J33-00	5842.6	224.7	26.02	16.00	93.04	9.88	1.50
99J31-00	5793.8	233.1	24.82	16.51	93.17	9.72	1.63
US H20	5394.8	238.4	22.61	16.73	93.53	11.51	2.04
98J24-01	5091.3	259.1	19.64	18.23	93.15	10.40	1.79
EL38	4069.1	225.7	17.98	16.26	92.47	14.95	2.25
Mean	6315.1	234.9	26.94	16.77	92.74	12.65	1.81
CV	16.43	6.83	16.42	5.20	1.04	26.51	19.13
LSD (0.05)	1584.0	16.21	6.46	0.77	1.71	5.91	0.53

II. Germination of Sugar Beet (*Beta vulgaris*) Under Stress Environments: A Survey of Differential Gene Expression *in vitro*

BSDF Project 741

Benildo de los Reyes – USDA-ARS Research Associate
and J. Mitchell McGrath

Background

Germination and seedling emergence are fundamental processes that determine potential harvest on sugar beet crops. Poor germination and emergence, due to biotic and abiotic stresses, are major problems with serious economic impact to the sugar beet industry. While external influences of the environment are well documented, and can be managed to a degree, the intrinsic responses of the plant to external signals such as those imposed stress are not well understood. We are particularly interested in these intrinsic responses because they provide the best evidence for the involvement of genes in stress response, and can give information on the identity of those genes and the conditions under which they are expressed. Ultimately, knowing which genes are expressed, and then deducing and proving which genes control or most influence the appropriate response(s) will allow their directed selection, genetic manipulation, and biotechnological utility for improving germplasm performance.

Genetic causes of emergence and stand reduction failures are not very well understood. Previous observations from both laboratory and field experiments (McGrath, BSDF Project 741) suggested the importance of genetics in the expression of seed vigor in the early stages of sugar beet growth. Expression of seedling vigor is influenced by a number of extrinsic and intrinsic components (Kneebone, 1976). Among the major factors that determine the extrinsic component include the seed production and post-harvest environments. These components account for the variability in germination ability between seed lots of the same cultivar and do not reflect the actual vigor potential of the cultivar. Intrinsic components are determined primarily by the genetic make-up of the seed, and likely some effects imposed by the maternal physiology. Our results to date indicate the problem of poor germination and emergence in sugar beet fields are largely abiotic. Stand reductions after maximal emergence, the stand persistence problem, are largely due to disease. These phases are not mutually exclusive, and likely overlap to an undetermined extent.

The inability of certain cultivars and seedlots to adapt to sub-optimal conditions in the germination environment is clear, but responses are difficult to dissect in field grown materials. Previous laboratory experiments involving artificial stress showed significant differences in the ability of sugar beet cultivars to germinate in aqueous solutions supplemented with different solutes. Some adjuvants promote (i.e. 0.3% hydrogen peroxide) or inhibit (e.g. pure water, 350mM NaCl, 200mM mannitol) germination relative to 'traditional' germination on moist filter paper. Among the cultivars studied, USH20 exhibited superior germination under both artificial stress (laboratory) and actual field conditions, compared to two other cultivars (HME17 and ACH185) that exhibited good and poor vigor, respectively. Based on these findings, the major stress factors that significantly affect the expression of sugar beet seed vigor were identified to include the extremes of moisture (flooding and drought), salinity and anoxia (anaerobic stress).

The objective of this research project is to dissect the molecular components determining the expression of seed vigor in sugar beet, through the discovery of cultivar specific, differential gene action in response to sub-optimal germination environments. The isolation, identification and characterization of specific genes that contribute to abiotic stress tolerance expressed during germination is the primary approach. These genes include those that are either induced or repressed in the cultivar USH20 under specific stress conditions. Future work will include comparisons among good and poor stress emergers.

Discovery of genes with potential roles in stress-tolerance at the germination stage will result in better understanding of the physiological and biochemical processes that limit the expression of seed vigor in sugar beet. This will be important in developing strategies to improve seed vigor by genetic engineering. Along with other genes expressed in germinating seeds, the putative stress-related genes are currently being used as markers (restriction fragment length polymorphism or RFLP) to develop a genetic map of the sugar beet chromosomes. This map will not only provide better understanding of the genetic architecture of the sugar beet genome but will also serve as a more direct route to investigate the chromosomal distribution of gene loci with potential roles in the expression of seed vigor.

Experimental Approach

The cultivar USH20, a good stress-germinator, is our model system to identify genes with potential roles in stress-tolerance at the germination stage. The basic strategy has been to compare gene expression profiles under different laboratory environments. Three types of treatments include germination in moist filter paper (standard or control), submerged germination in pure water or solutions containing 350mM NaCl or 200mM mannitol (stressed or negative treatment), and germination submerged in 0.3 % hydrogen peroxide (positive treatment).

Total RNA samples were isolated by guanidine hydrochloride method from seedlings germinated for 4 days. Differential gene expression analyses were done by comparing mRNA (messenger RNA) fingerprints generated by the differential display-reverse transcription polymerase chain reaction (DDRT-PCR) technique (Liang and Pardee, 1992), using the Delta Differential Display kit (Clontech, Palo Alto CA). Differentially expressed (up- and downregulated) cDNA copies (complementary DNA, reverse copied from mRNA) were identified by comparing mRNA fingerprints' relative band intensities in autoradiograms. Candidate cDNAs were cloned in pT-Adv plasmid vector (Clontech, Palo Alto CA) and the inserts were sequenced by dideoxy-termination method in the Long ReadIR4200 automated DNA sequencer (Li-Cor, Lincoln NE). The putative identity of individual stress-induced cDNA was determined by alignment of nucleotide sequences with known genes in genome databases (GenBank, EMBL, DDBJ) using the blast search algortihms (BlastN, BlastX) (Altschul et al., 1997). The expression of the candidate genes was confirmed through northern blot analysis, by probing mRNA (2 ug) isolated from individual treatment with the radiolabeled cloned cDNAs.

Results

Our initial survey of differential gene expression in USH20 resulted in 807 cDNA fragments, which were amplified using 50 combinations of anchored and arbitrary primers (Clontech, Palo

Alto CA). The patterns observed in the mRNA profiles indicated significant changes in gene expression under optimal and sub-optimal environments. Of the total 807 bands observed, 95% corresponded to genes that were expressed in all treatments. The other 5% showed induced expression in response to at least one treatment. Some of these have been cloned and their nucleotide sequences have been obtained. A partial list of these differentially expressed cDNAs and their induction and expression is given in Table 1.

Table 1. Partial list of up-regulated cDNA clones isolated by differential display analysis of germinating sugar beet (cv. USH20). This list includes only the clones whose expressions were confirmed by northern blot analysis.

CloneID	Primer pair	Partial cDNA size	Induction	Putative identity
L1	P1/P1	827 bp	NaCl, H_2O_2	ATPase
L2	P1/P1	668 bp	NaCl, H_2O_2	unknown[1]
L5	P5/P5	484 bp	solution	unknown[1]
L7	P8/P8	670 bp	solution	unknown
L8	P9/P9	768 bp	H_2O_2	sugar-PO_4 translocator
L9	T1/P9	625 bp	H_2O_2	cytochrome b
L16	P8/P8	598 bp	solution	unknown
L18	P2/P3	622 bp	solution	pectinacetyl esterase
L19	P2/P4	327 bp	NaCl	unknown
L20	P2/P5	520 bp	filter paper	unknown
L21	P2/P5	322 bp	NaCl	unknown
L22	P2/P5	526 bp	NaCl	unknown
L24	P2/P6	283 bp	mannitol	unknown
L13	T2/P4	420 bp	all	40S ribosomal protein

[1] similarity to unknown protein in Arabidopsis

Where the function of these clones has been surmised from matches in the world genome databases, further discussion is included below, particularly as it relates to potential clues for stress germination mechanisms and targets for further analyses and manipulations.

Sugar-phosphate translocator protein and Cytochrome b

About 0.4% of the total cDNAs were upregulated in response to germination in hydrogen peroxide solution. The identities of two of these genes were positively identified as cDNAs encoding a sugar-phosphate translocator protein (L8) and cytochrome b (L9), based on significant sequence homology of the partial cDNAs with other known genes in genome databases. Both of the genes exhibited high levels of expression in seedlings germinated in 0.3% hydrogen peroxide relative to the other treatments. The patterns of expression were identical in the differential display profile and northern blots (Figure 1). These results were interpreted as a possible indication of coordinate regulation of expression of these two genes and may be related

to a common path of metabolic adjustment when germination occurs in the presence of hydrogen peroxide. Our initial hypothesis is that hydrogen peroxide relieves anaerobic stress under condition of excess water during germination in solution. We propose the following hypotheses to explain the possible physiological relevance of the current results in relation to our initial hypothesis regarding the role of hydrogen peroxide as the source of oxygen during germination.

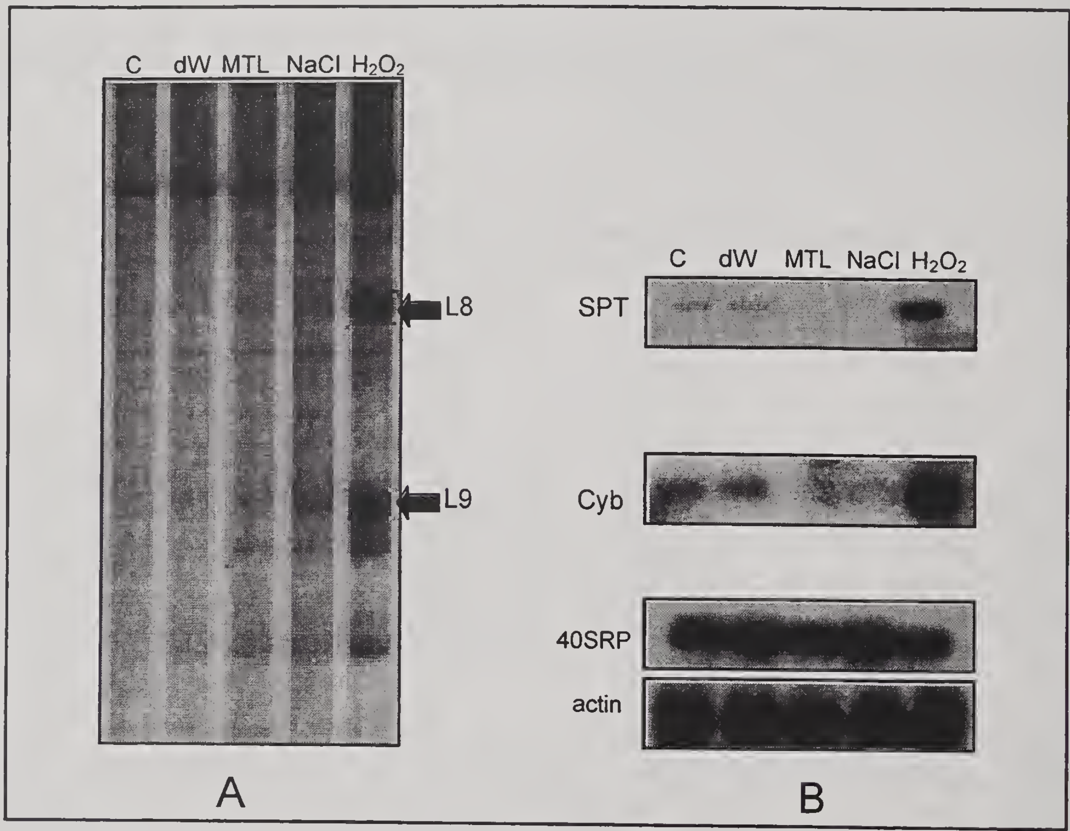

Figure 1. Expression of genes encoding sugar-phosphate translocator protein, SPT (L8) and cytochrome b, cyb (L9) during germination of USH20 in hydrogen peroxide. (A) Differential display of mRNA from seedlings germinated on moist filter paper (control, C), distilled water (dW), 200mM mannitol (MTL), 350mM sodium chloride (NaCl) and 0.3% hydrogen peroxide (H_2O_2). Induced gene expressions are shown by bands L8 and L9 which are present in samples germinated in H_2O_2 but not in the control and other treatments. (B) The bands L8 and L9 were isolated and used as probes to confirm differential gene expression by northern blot analysis. Expression patterns show significant increases in transcript levels corresponding to SPT and cyb genes in the H_2O_2 treated sample. Uniform transcript levels in all samples show constitutive pattern of expression of "housekeeping" genes (40S ribosomal protein/40SRP and actin).

Respiration and oxidative phosphorylation are two of the major metabolic processes that are immediately activated upon imbibition. These processes occur in the presence of oxygen and

provide the ATP (energy) that fuels cellular processes related to germination including cell wall elongation and extension/emergence of the radicle (Nykiforuk and Johnson-Flanagan, 1998)). The increased expression of the cytochrome b gene/s suggests a rapid development of the mitochondrial electron transport system more likely as a consequence of more stable supply of oxygen to the germinating embryo, in the presence of hydrogen peroxide than in solution of pure water. This observation further supports the results from last year's experiments, which indicated that anaerobic stress appears to be a major factor that affects sugar beet germination and emergence.

The substrates for oxidative phosphorylation come from the by-products of sugar metabolism via glycolysis and TCA cycle (Heydecker, 1977). The availability of steady supply of oxygen in the germination solution (hydrogen peroxide treatment) possibly resulted in increased demand for respiratory substrates (feedback control). Based on the current results, we hypothesized that the upregulation of expression of a gene encoding a sugar-phosphate translocator protein is probably related to a mechanism by which respiratory substrates are mobilized to the cytoplasm for glycolysis. Biochemical studies in other plant species indicated the presence of both triose- and hexose-phosphate translocator proteins in amyloplast of non-photosynthetic organs such as the roots and germinating seeds. Unlike their chloroplast counterparts, these proteins transport not only triose-phosphates but also residual hexose-phosphates across the amyloplast envelop to the cytoplasm where they can be utilized for glycolysis (Echeverria et al., 1988; Borchert et al., 1989; MacDonald and Rees, 1983). The possible occurrence of this process in sugar beet (as suggested by the current results), probably ensures that sufficient supply of respiratory substrates are available to meet the energy demand for germination under ideal conditions, an indirect but positive effect of hydrogen peroxide.

ATPase

Salt stress (350mM NaCl) during sugar beet germination induced the expression of several genes. One of the salt-induced cDNAs (L1) was positively identified as that encoding for a membrane-bound ATPase, based on significant sequence homology of the partial cDNA with other ATPase genes in the genome databases. ATPase is an integral component of proton pumps located in the plasma membrane and tonoplast. This protein is involved in active transport of ions from the cytoplasm to the intercellular space and vacuole. Both the differential display profile and northern blot indicated that a putative ATPase gene was highly upregulated during germination in salt and hydrogen peroxide solutions in addition to the basal expression levels in the control (moist filter paper) and other stress treatments (Figure 2). This result suggests that regulation of this gene may be important not only for growth-related processes but also for some stress-related response (Lehr et al., 1999). The potential physiological significance of the salt-induced expression of ATPase gene/s during sugar beet germination may be related to an energy-requiring mechanism that maintains low level of Na^+ inside the cytoplasm, which could otherwise produce damaging effects to the germinating embryo (Apse et al., 1999; Frommer et al., 1999).

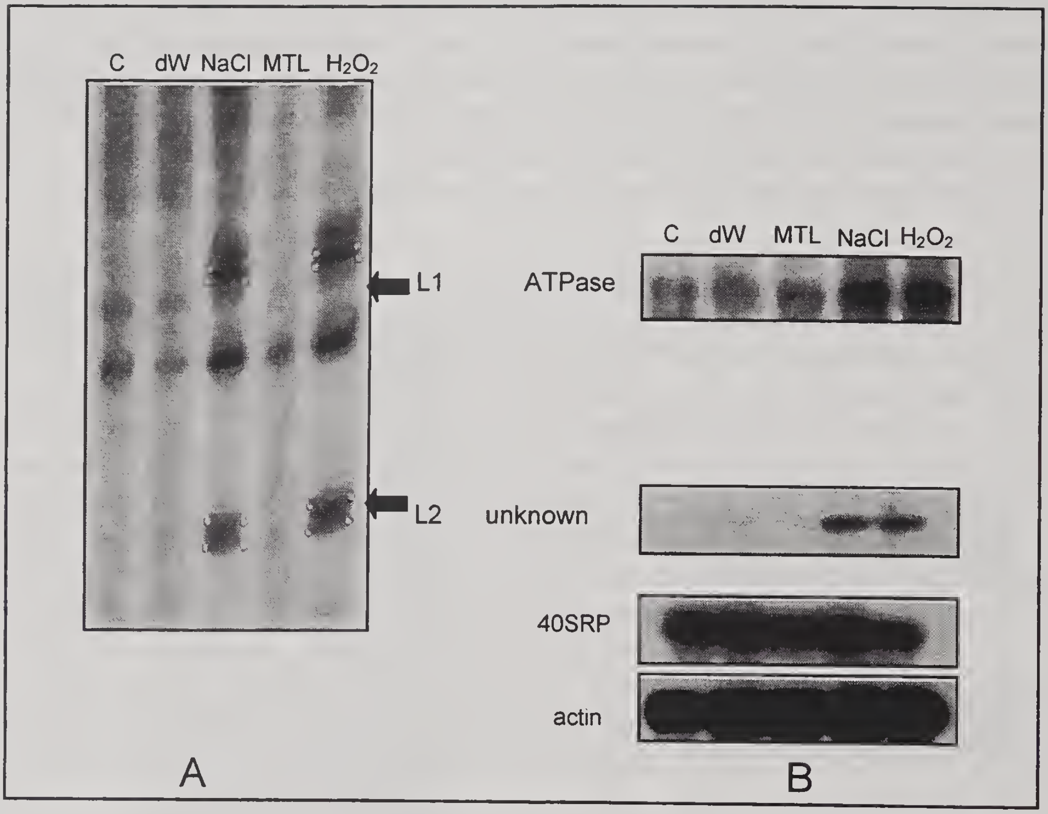

Figure 2. Expression of genes encoding ATPase (L1) and an unknown protein (L2) during germination of USH20 in sodium chloride and hydrogen peroxide. (A) Differential display of mRNA from seedlings germinated on moist filter paper (control, C), distilled water (dW), 200mM mannitol (MTL), 350mM sodium chloride (NaCl) and 0.3% hydrogen peroxide (H_2O_2). Induced gene expressions are shown by bands L1 and L2 which are present in samples germinated in NaCl and H_2O_2 but not in the control and other treatments. (B) The bands L1 and L2 were isolated and used as probes to confirm differential gene expression by northern blot analysis. Expression patterns show significant increases in transcript levels corresponding to ATPase and the unknown gene in the NaCl and H_2O_2 treated samples. Uniform transcript levels in all samples show constitutive pattern of expression of "housekeeping" genes (40S ribosomal protein/40SRP and actin).

On-going Experiments

The preliminary results from this study suggest that many genes with basic "housekeeping" functions are regulated under stress conditions of germination. The expression patterns of these genes under optimal and sub-optimal germination environments are currently being compared between USH20 (good stress-emerger) and ACH185 (poor stress-emerger) to confirm their direct involvement in cultivar differences in seed vigor.

The putative identities for many of the cDNAs that we isolated are still unknown because of the lack of significant sequence similarity with other genes. These cDNAs are quite interesting because of the possibility that they represent novel genes with important roles in stress-tolerance during sugar beet germination. Recently, we constructed a cDNA expression library (in lambda UniZap-XR vector, Stratagene, La Jolla CA) from pooled mRNA from all six treatments on USH20. This library is currently being screened to isolate the full-length clones corresponding to all the cDNAs listed in Table 1. The full-length coding sequences of these cDNAs will be analyzed for potential structural motifs (at the nucleotide and amino acid sequence levels) that may provide clues regarding the biological role/s of these genes in sugar beet germination and emergence under stress environments. Furthermore, additional genes will be isolated and these efforts will be targeted towards identification of stress-specific genes.

Despite these efforts to isolate and identify genes associated with stress-tolerance during sugar beet germination, we still know very little about the genetic components that determine the expression of seed vigor. However, given the physiological complexity of tolerance to different stresses it is highly possible that hundreds of genes are involved, each one probably associated with specific adaptive mechanism. The result of the current survey of differential gene expression is still far from being comprehensive and does not provide adequate information to better understand the relationship between abiotic stress-tolerance and seed vigor in sugar beet. The initial strategy of using differential display provided useful preliminary information but the results were obviously quite limited in scope. Apparently, a larger scale gene discovery and characterization program will be necessary to satisfy the original goals that were set at the beginning of this research project and to realize the full potential of this project to generate innovative tools for sugar beet improvement.

Our survey of differential gene expression using differential display is still on- going. Additionally, in order to approach this problem in a more functional and global perspective, we are currently developing a small collection of Expressed Sequence Tags (ESTs) from the cDNA library developed from germinating sugar beet seeds. Basically, this collection will be a sub-sample of partial sequences of the genes that are active during germination under optimal and sub-optimal environments. Our strategy for the generation of this EST collection involves the preferential elimination of the clones from the library that correspond to genes that are not involved with stress- and hydrogen-peroxide induced responses using the methods known as subtractive hybridization and differential screening (Nguyen et al., 1995; Hoog, 1991). The resulting sub-libraries (one each for stress and hydrogen peroxide) represents a snapshot of induced gene expression that will then be characterized by partial sequencing (300-450 bp) from the 5' ends of the individual cDNAs. During the past decade, voluminous amount of gene sequence information had become available in public databases. These databases consist of gene sequence information from both prokaryotic and eukaryotic organisms and include a number of disease causing microorganisms (Saier, 1998), some model plant species like rice (Sasaki et al., 1994) and *Arabidopsis* (Cooke et al., 1996) and also human (Hillier et al., 1996). These existing databases will be searched for potential homologies with the individual ESTs generated from the subtracted germination-specific cDNA library of sugar beet. This approach will allow a more rapid and direct access to hundreds (or even thousands) of genes and will serve as the foundation for studying global changes in gene expression patterns associated with the ability of sugar beet to germinate under stress. Homologies with other genes or gene motifs whose function had been previously identified will provide wider windows on the molecular genetic basis of seed vigor in a more functional perspective. This approach also offers exciting opportunities to discover novel

metabolic pathways relevant to germination. Future major benefits from this initiative will include opportunities to investigate this problem using more sophisticated tools of genomics including the use of DNA chips and transcription profiling (Roberts et al., 2000). These technologies are predicted to be of huge impact not only to basic research in biology but also to plant breeding and cultivar improvement in the new millennium. Lastly, the small scale EST collection from this project is being used as a foundation to study the genome architecture and evolution of *Beta vulgaris* through the construction of an EST marker-based genetic map of the sugar beet chromosomes.

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GROWTH OF SUGARBEET PATHOGENS IN VITRO.

Joseph W. Saunders

RHIZOCTONIA AND PYTHIUM. The sensitivity of in vitro growth of sugarbeet fungal pathogens *Rhizoctonia solani* (RZT) and *Pythium ultimum* (PYT) to three herbicides (Roundup, Liberty and Pursuit), each affecting separate individual amino acid biosynthetic steps, was evaluated under conditions of both nutritional dependance and independence on inorganic nitrogen from the culture medium. One isolate each of RZT and PYT was grown on various concentrations (0, 2.1-21000 μM active ingredient) of each of the three herbicide formulations in agar plates with a Murashige-Skoog nutrient medium background, with each of four medium nitrogen regimes: no nitrogen, or nitrogen provided at 30 mM as either casein hydrolysate, ammonium, or nitrate.

For all three herbicides with PYT, nitrogen regime did not affect sensitivity of extension growth of the fungus to the herbicide; PYT was increasingly sensitive to Pursuit, Round-up, and Liberty, in that order. RZT showed the same order of sensitivity to the three herbicides. Nitrogen source only had a significant effect on RZT sensitivity to the herbicide in the case of Liberty, where extension growth on casein hydrolysate as nitrogen source was about tenfold less sensitive to the herbicide than with the three other nitrogen sources. The most noteworthy finding of the entire test was that RZT extension growth at the highest Pursuit concentration (ie, 21,000 μM), for each of the nitrogen sources, was at least 50% of the growth in the absence of the herbicide. This appears to be a remarkable tolerance of RZT to the herbicide.

This research was prompted by the question of whether RZT or PYT, each a facultative saprophyte, would be sensitive ("fungicidally") to the presence of a herbicide such as might be encountered in field soil, and might thus be controlled to some degree incidentally by herbicides used as part of cell-selection or transgenic herbicide-resistant variety packages. Of the three herbicides, only Pursuit is known to be persistent in soil. However, the absence of lower sensitivity to the herbicide of extension growth with casein hydrolysate (essentially a mixture of amino acids) as nitrogen source in five out of six combinations suggests that herbicide-induced deficiency of one or more amino acids is not an obvious explanation for growth inhibition by the herbicides.

CERCOSPORA. In continued research with *Cercospora beticola* (CER) inoculated onto Murashige-Skoog plant tissue culture medium, when six CER mycelium plugs were placed on one side of a plate with 1.0 mg/L N^6-benzyladenine medium, with a leaf disc placed on the other side 13 days earlier, and grown on the lab bench under ambient lighting from ceiling fluorescent lamps, CER growth for two weeks was limited in extent, with no cercosporin production, based on lack of red color in the agar. When CER growth on the surface of the agar ceased, sparse hyphae extended to the leaf disc. Thirteen weeks after inoculation with CER, mycelium had grown on the leaf disc, and produced conspicuous red coloration (cercosporin) in the medium surrounding the leaf disc, but still not in proximity to the dense mycelial masses around the inoculum plugs.

The differential accumulation of cercosporin on different sides of the Petri dish was consistent with a conjectured late presence of organic N or late absence of nitrate from the vicinity of the leaf disc, consistent with cercosporin accumulation we have seen and measured by HPLC from CER on water agar, nitrogen-free Murashige-Skoog medium, and potato dextrose agar medium. Using both defined and undefined complex media, Ehrenshaft and Upchurch

(1993) had reported that host protein(s) induce, and nitrate represses, accumulation of cercosporin in a phytopathogenic strain of *Cercospora kikuchii,* a pathogen of soybean. This induction of cercosporin accumulation in the vicinity of the sugarbeet leaf disc should be pursued further with a range of germplasm including CER resistance and susceptibility. Differential production of cercosporin by the pathogen in leaf tissue of resistant vs susceptible genotypes could be one mechanism of genetic resistance by the host. Perhaps it also could explain the 'resistance' of young leaves on the host plant.

PUBLICATIONS

J.W. Saunders[1] and C.J. Tsai. 1999. **Production of somatic embryos and shoots from sugarbeet callus: Effects of abscisic acid, other growth regulators, nitrogen source, sucrose concentration and genotype.** In Vitro Cell. Dev. Biol. –Plant 35:18-24.

ABSTRACT Two sugarbeet (*Beta vulgaris* L.) genotypes, REL-1 and REL-2, were used to measure the level of somatic embryo and shoot production from hormone-autonomous callus plated under varied nutrient medium combinations of abscisic acid with the growth regulators 6-benzyladenine, 1-naphthaleneacetic acid, or 2,4-dichlorophenoxyacetic acid, with eight sole nitrogen sources, or with different sucrose concentrations. Clone REL-2 produced embryos up to thirty-five fold more frequently than clone REL-1. Inclusion of abscisic acid at some concentrations consistently improved embryo production in all experiments, and was observed to stimulate shoot production. At some concentrations, 1-naphthaleneacetic acid as well as urea and glutamine stimulated greater embryo production over the control, but only for REL-1, where there was greater room for improvement. Three and five percent sucrose were superior to one, seven, and nine percent. Higher initial 6-benzyladenine concentration (in the range 0, 0.1 - 1.0 mg/L) was associated with lower embryo production but greater shoot regeneration for both clones. REL-2 was significantly better than REL-1 in shoot regeneration. The range of embryo production was more than thirty-five fold between genotypes, whereas the range of physiological effects was no greater than ten-fold. REL-2 has been released to sugarbeet researchers because of its superior embryogenic and shoot regeneration abilities for application in biotechnology.

C.J. Tsai and J.W. Saunders. 1999. **Encapsulation, germination, and conversion of somatic embryos in sugarbeet.** J. Sugar Beet Res. 36:11-32.

ABSTRACT Sugarbeet somatic embryos (SE) of biotech clone REL-2 obtained from callus grown with abscisic acid were experimentally encapsulated with 2% alginate and subsequently germinated and converted into plantlets, in initial efforts necessary for development of artificial seeds. Factors examined were embryo size, alginate companion solution, cold storage duration, and germination substrate. Nonencapsulated SE length category (0.5-1.9, 2.0-2.9, or 3.0-3.9 mm) did not affect germination (GERM) or conversion (CON) rates (87, 89, 87 %, respectively) into complete plantlets on hormone-free Murashige-Skoog (MS) medium. Alginate companion solutions (either hormone-free MS medium or H_2O) had no differential effect on GERM rate (100 %) but did differ in converting embryos to plantlets (81 vs. 64 %, respectively). Subsequent experiments examining cold storage of encapsulated embryos at 4 °C found no lower rate of CONability at 25 °C after 21 days of cold compared with unstored embryos, but after 64 days of

storage at 4 °C, the GERM and CON rates at 25 °C of embryos encapsulated with alginate in MS medium was lower (70 and 45 %, respectively). With alginate in H_2O, respective rates after 64 days of storage at 4 °C were 60 and 20 %. In addition, the GERM rate in soil plates after 64 days cold storage for alginate capsules in MS medium or in H_2O was 38 or 25, respectively. This initial research showed that SE, either nonencapsulated or encapsulated, converted into plants at high frequencies (88 and 81 %, respectively) without cold treatment. Cold storage did not improve the CON rate of encapsulated embryos, but did slow their development. However, these experiments indicated that nonencapsulated and encapsulated embryos were capable of direct GERM after planting on agar plates and in soil.

GERMPLASM REGISTRATIONS

Saunders, J.W., J.M. McGrath, J.M. Halloin, and J.C. Theurer. 1999. **Registration of SR94 sugarbeet germplasm with smooth root.** Crop Sci. 39:297.

Saunders, J.W., J.C. Theurer and J.H. Halloin. 1999. **Registration of EL50 monogerm sugarbeet germplasm with resistance to Cercospora leaf spot and Aphanomyces blackroot.** Crop Sci. 39:883.

MASTER OF SCIENCE (M.S.) DISSERTATION (Graduate Advisor: J. W. Saunders):

Goran Srnic, "Inheritance and Intercellular Fluid Protein of a Foliar Disease Lesion Mimic Trait in Sugarbeet (*Beta Vulgaris* L.)" Crop and Soil Sciences, Michigan State Univ., 1999.

Abstract: Disease lesion mimic (DLM) phenotypes in crop plants are characterized by water-soaked spots and lesions on foliage, but close association with forms of disease resistance has been discovered in most such cases. A single DLM sugarbeet from a breeding population was used as a parent in determining the inheritance of the DLM phenotype, using segregation patterns of F_1, F_2, F_3, and BC_1 progenies from a single DLM X wild type cross. Expression of this DLM trait is proposed to be conditioned digenically, by homozygosity of a recessive allele at one locus, and by the simultaneous presence of at least one dominant allele at the second locus (i.e., dlm_1/dlm_1: $Dlm_2/-_2$). DLM occured on older leaves, but was not seen on shoots and plantlets grown on various media in vitro. When intercellular fluid (ICF) proteins were extracted and visualized, defense proteins, including those with chitinase activity, appeared more abundant in leaves from DLM than from wild type plants.

MEETING ABSTRACTS

J.W. Saunders. **The Concept of Minimum Assured Frequency of (CMS)-Maintainer Alleles (M.A.F.M.A.) in USDA-ARS Sugarbeet Germplasm Enhancement.** 1999 American Society of Agronomy annual meeting, Oct 31-Nov 4, Salt Lake City.

Sugarbeet germplasm from ARS has had direct use potential as parental lines in hybrid cultivars. Most monogerm releases have been Type-O (homozygous for both recessive CMS maintainer alleles *x* and *z)*, developed only by labor-intensive, calender-consuming identification of Type-O plants, found at 1% or less in most populations, using testcross progeny. Misscoring of testcross progeny occurs in some environments; a 5 degree C difference gave plentiful pollen (25 C) and white anthers (30 C). Recent ARS releases have been less usable as parental lines, as emphasis has shifted to germplasm diversity and combined traits in less finished form. Assurance of CMS maintenance in releases (ie, Type-O) is costly to create, and could be done by the seed industry using ARS releases with pedigree-based minimum assured frequencies of maintainer alleles (ie, M.A.F.M.A.). To that end, population creation and improvement relying on Type-O SP 69550-0 to add higher SUC% to germplasm otherwise high in root smoothness or Rhizoctonia crown and root rot resistance is in progress at East Lansing.

J.W. Saunders. **Sugarbeet tissue culture media differentially support the growth of sugarbeet pathogens *Rhizoctonia solani, Pythium ultimum, Cercospora beticola*, and *Aphanomyces cochlioides*.** 1999 American Society of Sugar Beet Technologists biennial meeting, Feb 10-13, Orlando FL.

Co-culture of pathogen and host plant tissue in vitro offers prospects for studying host defense gene expression, and opportunities for identification and cell selection of resistant genotypes, but pathogen growth characteristics on the medium used to culture the host tissue can determine the feasibility of such systems. Single isolates of sugarbeet pathogens *Rhizoctonia solani* (RZT) and *Pythium ultimum* (PYT) grew well (about 2 cm/day) from mycelial plugs on Murashige-Skoog agar medium with standard 60 mM nitrogen from nitrate and ammonium. *Cercospora beticola* (CER) grew more slowly (about a tenth as fast), and *Aphanomyces cochlioides* (APH) spread rapidly but sparsely. Pathogen growth was also evaluated on nitrogen source variations of MS medium, where the most noteworthy observation was that RZT, PYT and CER grew well with only nitrate as nitrogen source. In general, growth of RZT, PYT, and CER in liquid forms of the media corresponded to growth quantity on the agar versions. APH did not grow at all in liquid MS media with inorganic forms of nitrogen nor with urea, and its sparse growth on corresponding agar media appears due to nitrogenous and sulfurous impurities in the Difco Bacto agar. All pathogens grew to, over, and into sugarbeet tissue cultured on the same plate, leading to host tissue death. CER (due to slow extension growth) and APH (due to sparse growth) should be suitable for future co-culture research with sugarbeet tissue cultures.

GERMPLASM RELEASES

NOTICE OF RELEASE OF EL52 MONOGERM SUGARBEET GERMPLASM RESISTANT TO RHIZOCTONIA CROWN AND ROOT ROT, APHANOMYCES BLACKROOT, AND CERCOSPORA LEAFSPOT, AND ENRICHED FREQUENCY OF CMS-MAINTAINER ALLELES

The Agricultural Research Service of the U. S. Department of Agriculture, the Michigan Agricultural Experiment Station, and the Beet Sugar Development Foundation announce the joint release of EL52, a sugarbeet germplasm selected for resistance to root-rotting strains (anastomosis group AG-2-2) of *Rhizoctonia solani* Kühn. EL52 was developed at the Sugarbeet and Bean Research Unit, East Lansing, Michigan by the sugarbeet breeding team of Drs. J. W. Saunders, J. H. Halloin. J. M. McGrath, and G. J. Hogaboam (deceased). EL52 also has excellent resistance to Cercospora leaf spot caused by *Cercospora beticola* Sacc. and to blackroot seedling disease and root rot caused by *Aphanomyces cochlioides* Drechs., two of the most destructive sugarbeet diseases in the United States. EL52 is an expected source for development of monogerm parental lines for hybrid cultivars resistant to these three diseases.

EL52 is monogerm, segregates for red and green hypocotyl plants, and is predominantly self-sterile: 6 percent of plants sampled were highly self-fertile. EL52 is enriched for the frequency of the recessive *x* and *z* alleles which in the joint homozygous condition maintain male sterility in plants possessing the sterile (S) cytoplasm. EL52 is a bulk of predominantly half-sib seed from 13 of 51 interpollinated plants that had been selected for freedom from disease and for root conformation in the 1997 East Lansing Rhizoctonia crown and root rot nursery. The 51 plants were selected from the six most resistant of 20 half-sib families evaluated in that 1997 nursery. Those 20 half-sib families originated on twenty plants of the half-sib family 85B1-R26 in a crossing block in 1997. 85B1-R26 was one of 25 half-sib families produced in 1985 by interpollinating four tissue culture propagated ramets each of 26 cloned plants. Twenty-five of these plants were from the interrelated East Lansing and Beltsville germplasm pools, and had been selected at East Lansing during 1978-83 from the Rhizoctonia or Cercospora disease nurseries, cloned, and identified as Type-O or near-Type-O individuals. A plant is classified as Type-O or near-Type-O if, by cross to a cytoplasmic-nuclear male sterile tester, its progeny are all, or almost all, respectively, male sterile. Type-O plants have normal (N) cytoplasm and the double homozygous recessive genotype *xx zz*.

EL52 is moderately resistant to Rhizoctonia crown and root rot, scoring a disease index (DI) equivalent to that of Rhizoctonia resistant specialty cultivar American Crystal Hybrid 1353, but less resistant than resistant checks FC705/1 and FC703 (4.4 compared with 4.4, 3.8 and 3.2, respectively; mean of three readings; DI of 0 = no root rot, and 9 = all plants dead; $LSD_{0.05} = 1.1$) in the 1998 USDA-ARS evaluation at Ft. Collins, CO. EL52 is resistant to Cercospora leaf spot, receiving a 3.17 disease index compared with 3.25 and 5.33 for the resistant and susceptible checks, respectively (mean of three readings; DI of 0 = no leaf spots and 10 = all plants dead; $LSD_{0.05} = 1.23$), in the 1998 USDA-ARS evaluation at Ft. Collins, CO. EL52 was not significantly different from SR87 and the two resistant checks (2.4 compared with 2.9, 2.1 and 2.5, respectively; mean of three readings; DI of 1 = full healthy stand and 9 = all plants dead;

$LSD_{0.05} = 1.17$) in the 1998 Betaseed summer root rot (Aphanomyces) evaluation at Shakopee, MN.

EL52 was tested under the number 98J26-052 where it yielded sucrose concentrations and tons of beets per acre 88 and 107 percent of the mean respectively of the two cultivars ACH555 (American Crystal) and HME17 (Hilleshog-Novartis) in one test at Saginaw, MI in 1998.

EL52 is being released as a germplasm source for breeders to use in developing parental lines combining resistance to Rhizoctonia crown and root rot, Cercospora leaf spot and Aphanomyces seedling disease and root rot. Seed will be maintained by USDA-ARS and is available for use by writing to J. Mitchell McGrath, USDA-ARS, Crop and Soil Sciences Department, Michigan State University, East Lansing, MI 48824-1325. Genetic material of this release has been deposited in the National Plant Germplasm System where it will be available for research purposes, including development and commercialization of new cultivars. It is requested that appropriate recognition be made if this germplasm contributes to the development of a new breeding line or cultivar.

Use of Seed Mixtures of *Rhizoctonia*-Resistant and Susceptible Sugarbeet Varieties for Control of Crown and Root Rot: Effects on Yield and Disease Occurrence.

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Background:

The pattern of disease development typically observed for Rhizoctonia crown and root rot is one where several to many contiguous plants within a row, or within a few adjacent rows are diseased, while plants in other adjacent rows remain nondiseased. This pattern of disease occurrence suggests that *Rhizoctonia* may spread through the soil and surmount the small gap between plants within a row more easily than the larger gap between rows. Occurrences of the disease tend to be widely scattered across fields, making the study of natural disease infestations and their development difficult, in that locations of sites if disease occurrences in a field cannot be predicted in advance of the occurrences.

Rhizoctonia-resistant sugarbeet varieties have become available to Michigan sugarbeet growers in recent years. Although these varieties have yields and sugar concentrations somewhat lower than available Rhizoctonia-susceptible varieties, their use has been advocated for locations where severe crown and root rot problems are anticipated. We proposed that because of the observed pattern of disease development, use of mixtures of seeds from both resistant and susceptible varieties might limit spread of the disease, reducing yield losses from disease, while minimizing yield reductions associated with the resistant varieties. Experiments using seed mixtures of *Rhizoctonia*-resistant and -susceptible varieties were done in 1998 and 1999 to determine the effects of seed mixtures on yields and disease severity. Because of anecdotal reports that crown and root rot often are severe on fields with no recent history of sugarbeet production, plots were planted at two such locations in 1999.

Methods:

Plantings were done at two locations at which severe crown and root rot was anticipated in 1998 (Hrabal and Terwilligar farms) and at two additional farms (Ivan and Helmrich farms) in 1999. Sites selected as having no recent history of sugarbeet planting were planted in 1999 at the Terwilligar farm and the Bean and Beet Research Farm. Varieties used were the *Rhizoctonia*-

resistant variety RH3, and the susceptible variety E17, and mixtures of the two varieties used contained 1/6, 1/3, and 1/2 RH3. However, at the Helmrich farm (1999), the *Rhizoctonia*-resistant variety C1353 and the susceptible variety C648 were used. Plots were four or six rows, and ran the length of the fields. Each variety or seed mixture was replicated three times in 1998 and four times in 1999 at each location.

Mature beets were harvesed with commercial harvesters, and yields were based upon beets harvested from entire plots. Disease incidences were based on counts of heavily diseased (dead, or with collapsed, necrotic foliage) plants within 600 meters of row within the plots.

Results and Discussion:

Yields (tons per acre and raw white sugar per acre) for plots at the three locations planted with RH3 and E17, and exhibiting crown and root rot are summarized in **Table I**. As anticipated, yields of both beets and sugar were lowest with the *Rhizoctonia*-resistant variety RH3; however, yields were highest with the mixture containing 1/6 (16%) RH3. This yield elevation with the 1/6 mixture of RH3 was statistically different from plots with 100% of either variety alone, when taken across all three locations. Disease occurrences at the three locations planted with varieties RH3 and E17 corresponded closely to percentages of the susceptible variety within plots (**Table II**).

No disease (Rhizoctonia crown and root rot) was observed in 1999 at either of the locations with no recent history of sugarbeet production. Similarly, yields did not show statistically significant differences among treatments at these locations (**Table III**). At the location planted with the varieties C648 (susceptible) and C1353 (resistant), no significant differences were observed among treatments in root yield, raw white sugar per acre, or disease incidence.

We conclude that growers may benefit from reduction of disease severity and enhanced yields when using mixtures of resistant and susceptible varieties containing approximately 1/6 to 1/4 of the resistant variety under conditions where severe crown and root rot is anticipated. Additionally, no statistically important yield penalty was observed when such mixtures were used under apparently disease-free conditions.

Table I. Root yield and raw white sugar per acre of plantings containing either individual sugarbeet varieties resistant (RH3) or susceptible (E17) to Rhizoctonia crown and root rot, or mixtures of the two varieties. Results are the means of observations at two locations in 1998 and one location in 1999 that exhibited losses due to crown and root rot, and are expressed as a percentage of observations for the susceptible variety E17.

Treatment	Root Yield	RWSA
	(percentage of E17)	
100% RH3	90.4	82.6
50% RH3+E17	99.4	95.3
33% RH3+E17	100.7	98.6
16% RH3+E17	105.3	103.0
100% E17	100.0	100.0

Table II. Root yield and raw white sugar per acre of plantings containing either individual sugarbeet varieties resistant (RH3) or susceptible (E17) to Rhizoctonia crown and root rot, or mixtures of the two varieties. Results are the means of observations at two locations in 1999 that exhibited no losses due to crown and root rot, and are expressed as a percentage of observations for the susceptible variety E17.

Treatment	Root Yield	RWSA
	(percentage of E17)	
100% RH3	98.6	93.8
50% RH3+E17	98.5	98.1
33% RH3+E17	100.3	98.0
16% RH3+E17	101.5	101.1
100% E17	100.0	100.0

Table III. Disease occurrence in plantings containing either individual sugarbeet varieties resistant (RH3) or susceptible (E17) to Rhizoctonia crown and root rot, or mixtures of the two varieties. Results are the means of observations at two locations in 1998 and one location in 1999 that exhibited losses due to crown and root rot, and are expressed as a percentage of observations for the susceptible variety E17.

Treatment	Disease Occurrence
	(percentage of E17)
100% RH3	32.1
50% RH3+E17	75.2
33% RH3+E17	70.5
16% RH3+E17	81.6
100% E17	100.0

Report on a seedling disease survey of Michigan sugarbeet fields, 1999.

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Background:

In recent years there has been increased concern by Michigan sugarbeet growers over declining stand establishment of the crop. While many factors go into the establishment of good stands, such as planting technique, soil structure, weather, seed processing and internal physiology of the seeds themselves, seedling disease is a major determinant. Six main fungal or fungus-like pathogens have been historically linked to seedling mortality in Michigan: *Aphanomyces cochlioides*, *Pythium aphanodermatum*, *Rhizoctonia solani* AG-2-2, *R. solani* AG-4, *Pythium ultimum* and *Phoma betae*. The first four pathogens are most virulent in warm soils and are largely controlled by disease avoidance, planting earlier in the spring so that sugarbeet seedlings grow out of their most vulnerable stage before these pathogens become active. *P. ultimum* and *Phoma betae* cause seedling disease at lower temperatures than the others; all commercially-planted sugarbeet seed in Michigan is coated with metalaxyl and thiram fungicides designed to protect against against *Pythium* spp. and *P. betae*, respectively. Recently, *Pythium* strains pathogenic on sugarbeets and resistant to metalaxyl have been isolated from Minnesota sugarbeet fields (Brantner and Windels, 1998). Because of changing cultural practices as well as the potential for pathogen evolution to overcome current control measures, we initiated a disease survey for known sugarbeet pathogens in fields exhibiting stand or seedling disease problems in 1999, and assessed the *Pythium* isolates for resistance to metalaxyl control methods.

Methods:

Disease survey - Twenty-six fields exhibiting stand establishment or seedling disease problems were identified by Monitor Sugar Co. or Michigan Sugar Co. field personnel. Fields were sampled once in April, May or June, representing the range of planting dates (about 3 weeks to 1 month before sampling) in the 1999 growing season. Seven to ten seedlings with representative disease symptoms were taken from each field. Since field isolations of diseased tissue is sometimes unsuccessful in terms of isolating the causal pathogen, in June, July and August, soil samples were taken from 19 of the 26 fields sampled earlier. Samples consisted of soil immediately below the surface (1-6 cm below surface) dug from several stand gaps, likely to have been sites of seedling disease, which were then pooled into a bulk sample.

Field-sampled seedlings were placed into plastic bags and returned to the lab for further processing. Seedlings were surface-sterilized for 30 seconds in 1% bleach (10% strength of bottle), rinsed 2x in sterile distilled water (dH_20), and incubated in either 100X20mm culture tubes or on water agar (WA), for purposes of identification. Subsequent transfers were maintained on corn meal

agar (CMA) (Sigma Chemical Co. C-1176) amended with 5mg benomyl/L CMA or 30mg/L CMA metalaxyl to inhibit growth of ascomycetous contaminating fungi or *Pythium* spp. respectively.

Samples of field soil were tested for the presence of seedling pathogens by a bioassay method. Field soil was mixed in a 1:1 ratio with a sterile greenhouse mix consisting of 3:1 sterile field soil:vermiculite to facilitate drainage, and placed into 9 cm diameter round plastic pots. These were planted with 25 sugarbeet seeds (variety: E17) treated with an indicator dye and one of the following fungicide seed treatments: metalaxyl, thiram, metalaxyl + thiram, or no fungicide. Treated seed was kindly supplied by Mr. Kyle Rushing of Gustafson, Inc. The pots were then incubated at either 15 or 25∘C (59 or 77∘F), placed in individual saucers and watered from below throughout the experiment to prevent crusting. The two temperatures were used to mimic early or later season soil temperatures in the field; the seed treatments were included to prevent “mini-epidemics” of certain pathogens (especially *Pythium* spp.) masking the presence of other pathogens. Two replications of each seed treatment/temperature combination were included. After incubating the pots for 15 days, we harvested any seedlings with disease symptoms. The seedlings were not surface as above, because of concerns that the sterilization procedure eliminated many of the superficially-infecting *Pythium* spp.: seedlings were washed free of soil with tap water, and otherwise treated as outlines above to identify potential pathogens.

Testing for pathogenicity and metalaxyl tolerance of *Pythium* spp. - Since many *Pythium* spp. are saprophytic, including many isolates of species pathogenic on sugarbeets, all cultures of *Pythium* isolated from diseased seedlings were tested for pathogenicity using the methods outlined in Branter and Windels (1998). Briefly, cultures to be tested were grown on 9 cm petri plates of WA (15 g/L; Bacto-Agar, Difco. Co) for 3 days. Then, the entire agar culture was scooped out of the plate was placed inside 9 cm round plastic pots with greenhouse mix (composition as above) and covered with ~5mm of soil. Atop this layer were placed 20 untreated E-17 seeds which were then covered with ~5mm of soil. Pots were incubated and 15 or 25∘C, and the cultures were termed pathogenic if seedling stands within each pot differed significantly from blank WA control pots.

Metalaxyl resistance was assessed for all *Pythium* spp., using the methods outlined in Branter and Windels (1998). Isolates with >50% of the growth of non-metalaxyl amended CMA plates on 1ìg metalaxyl/L CMA plates were classified as metalaxyl-tolerant.

Results and Discussion:

Disease survey - The most-isolated putative pathogens in April were *Pythium* spp., but tests of their pathogenicity revealed that only 2 out 12 isolated were pathogenic (Table I). Only 2 out of 10 fields reported pathogenic *Pythium* spp. One field had two seedlings containing *R. solani*. A range of other fungi such as *Papularia*, *Stemphyllium* and *Alternaria* were isolated (data not shown) usually classified as saprophytes or weak pathogens. It seemed likely that most of the fungi isolated from seedlings in April were “symptoms” rather than causes of disease; seedlings were weakened or damaged by other factors such as the mild frost which hit the sugarbeet growing area in mid –April of 1999. However the isolation method (which included a surface-sterilization) may have excluded certain *Pythium* spp. and certainly the small sample size in any particular field may have underestimated (or overestimated) the relative importance of a particular pathogen. In testing of soil

samples from the same fields (Table II, fields 429-2 through 429-10) *Pythium* spp. were isolated from diseased seedlings in soil bioassays incubated at 15°, and a range of pathogens (*Pythium* spp, *A.cochlioides* and *R. solani*) were isolated at 25°C. Since soil sampled were taken from stand gaps, it is possible that the presence of these warm-soil pathogens may have exacerbated the stand problems in these fields.

In May and June, many more pathogenic *Pythium* spp. were isolated from the fiels, as well as some A. cochlioides and *R. solani* **(Table I)** which would be expected as warm soil temperatures are more conducive to seedling diseases caused by these pathogens.

In the soil bioassays, incubation at 15°C favored the isolation of *Pythium* spp. from diseased seedlings over *A. cochlioides* or *R. solani*; interestingly, *Aphanomyces cochlioides* was isolated from seedlings incubated at 15°C in fields 429-4 and 623-43 **(Table II)**. Work is underway to assess the temperature optima in terms of pathogenicity of these isolates. In all cases, fewer damping-off symptoms were seen at 15°C than 25°C; however, emergence counts were generally lower (data not shown). It may be possible that more pre-emergence damping-off occurred in 15°C soils. The pathogens isolated from these two incubation temperatures roughly mirrored the pathogens isolated from the field in the cooler soils of April and the warmed soils of May and June.

Metalaxyl resistance of Pythium spp. isolates – The presence of metalaxyl tolerance was limited to three (and possibly four) of the fields sampled. However it was strongly correlated to pathogenicity: of the 12 pathogenic *Pythium* isolates recovered, 10 were metalaxyl tolerant. No pathogenic isolates of *Pythium* were recovered from one field, 609-28 (a field near an irrigation pond at the Bean and Beet Research Farm, St Charles, MI, a field with a history of heavy seedling mortality) but soil testing recovered many *Pythium* isolates from pots with seed treatments containing metalaxyl **(Table II)**. More work is necessary to assess their resistance to metalaxyl in vitro.

In the soil bioassay experiment, *Pythium* spp. were isolated, in general, in the untreated or thiram-only experiments, except in fields429-3, 609-28, 623-43 and 623-44 **(Table II)**.

Future sampling will continue in 2000, with additional soil testing of problem fields with the goal of developing a "Seeding Disease Potential" assay designed to forecast potential seedling disease problems with either a early or late-planting regime. Field sampling of seedlings will also be continued. Because of the low success rate of isolating known sugarbeet pathogens from symptomatic tissue, additional samples will be taken, and the pathogenicity of putative secondary colonizers of diseased tissue such as *Fusarium* and *Alternaria* to sugarbeet seedlings will be assessed, to gauge if virulence to sugarbeet seedlings has developed in these fungi.

Reference:

Brantner JR and CE Windels. Variability in sensitivity to metalaxyl in vitro, pathogenicity, and control of *Pythium* spp. on sugar beet. Plant Disease. 82(8) pp. 896-899.

Table I: Number of known sugarbeet pathogens isolated from seedlings with disease symptoms sampled in April, May and June (early through late plantings) of 1999. Number of metalaxyl-tolerant Pythium isolates in parentheses.

Pythium spp.		*Aphanomyces cochlioides*	*Rhizoctonia solani*
Pathogenic (Metalaxyl tolerant)	Nonpathogenic (Metalaxyl tolerant)		
April			
2 (2)	10(0)	0	2
May			
7(6)	10(2)	3	2
June			
2(0)	3	4	5

Table II: Known sugarbeet pathogens isolated in soil bioassay experiment; sorted by code of field isolated from; temperature incubated (15°C or 25°C) and seed treatment (N=None; M=metalaxyl; T=thiram; M+T=metalaxyl+thiram). Pyth = *Pythium* spp., Rhiz=*Rhizoctonia solani*, Aph=*Aphanomyces cochlioides*

	15°C				25°C			
Field	N	M	T	M+T	N	M	T	M+T
429-2	Pyth				Aph	Aph Rhiz	Aph Rhiz	
429-3					Pyth	Aph Pyth		Aph Pyth
429-4	Pyth	Aph			Pyth		Pyth	Aph
429-5						Rhiz		
429-6								
429-9								
429-10					Pyth Rhiz	Aph Rhiz	Aph Rhiz	Aph Rhiz
521-15	Pyth				Pyth Rhiz		Pyth	
521-16					Pyth			
521-17								
521-18					Pyth	Rhiz		
521-19			Pyth				Pyth	
604-31								
604-32					Pyth			
604-33					Pyth		Aph Pyth	
608-25								
609-28	Pyth	Pyth		Pyth	Pyth	Pyth	Pyth	Aph Pyth
623-42					Pyth		Pyth	Aph Pyth Rhiz
623-43	Pyth	Aph Pyth	Aph		Rhiz	Rhiz	Pyth	Aph Pyth

SUGAR BEET RESEARCH

1999 REPORT

Section F

Texas Agricultural Experiment Station
Bushland, Texas

Dr. C. M. Rush, Professor

Cooperation:

Holly Sugar Corporation - Sugar Land, Texas
Western Sugar Company - Denver, Colorado

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CONTENTS

Interactions Between BNYVV and BSBMV

Charlie Rush
Bushland, Texas

In previous studies we have shown that BSBMV and BNYVV are wide spread in most sugar beet growing regions of the United States. The two viruses are often found together in the same fields and sometimes infecting the same beet. Most ELISA methods of virus detection are comparable to results obtained using Western Blots but in cases where the most accurate test results possible are required, molecular techniques, such as PCR, should be used. However, molecular tests are not appropriate for routine diagnostics because of expense and time requirements. Because of the similarities between BNYVV and BSBMV, cross-reactions in some ELISA tests are possible if test conditions are not suitably stringent.

BNYVV and BSBMV are very closely related at the molecular level and have the same genomic organization. The same soilborne fungus vectors the two viruses and conditions for disease development are similar. We have shown that BSBMV can cause significant damage to sugar beets, especially under conditions of high soil moisture. However, the greatest concern is the possibility of recombination between BNYVV and BSBMV. Recombination is relatively common between RNA viruses and is a recognized method that viruses use to develop new strains that can differ from the two "parents" in virulence. Although good disease resistance to BNYVV is available, it was unknown for sure whether BNYVV resistance genes also conferred resistance to BSBMV.

This year, we conducted studies to evaluate interactions between BNYVV and BSBMV at the field level. We conducted studies to verify the susceptibility of BNYVV resistant germplasm to BSBMV and also screened the core collection of *Beta maritima* for accessions with resistance to BSBMV. In addition, we conducted field studies to evaluate the effect of various irrigation rates on soilborne diseases of sugar beet caused by various soil fungi and soilborne viruses.

Methods

Interactions between BNYVV and BSBMV- A survey was made in Colorado and Minnesota for fields with BNYVV, BSBMV, or both viruses. Based on the results of an initial survey several fields were grid soil sampled. Selected fields were marked off in 60, one-acre grids and soil samples taken from each grid cell. Samples were geo-referenced for future identification. In addition to these grid soil samples, intensive sampling was conducted in several fields by taking grid samples on a 10' grid pattern. Soil samples were taken to the laboratory and bioassays were initiated by planting seed in individual samples. All soil samples from an individual field were planted at the same time, and field samples were planted approximately every six weeks. Plantings were staggered to allow time for sample processing after harvest, which is approximately 10 weeks after planting. After harvest, plants were tested by ELISA to determine the distribution of BSBMV and BNYVV in the field and by SSCP analysis to determine the degree of genomic variability of BSBMV in fields and the possibility of recombination. In one field, plant samples, in addition to soil samples, were taken from one of the intensively sampled fields. The intensive sampling in this field was in a BNYVV disease-screening nursery.

BNYVV germplasm resistance to BSBMV - In 1998, a rhizomania resistance cultivar nursery was sampled and we found that the BNYVV resistant cultivars seemed to be highly susceptible to BSBMV. In 1999, a study was initiated to determine whether cultivars with genetic resistance to BNYVV were susceptible to BSBMV. Twenty entries with varying levels of resistance to BNYVV, ranging from 0-100%, were grown in a field naturally infested with BSBMV and BNYVV. Two times during the season, samples were collected and tested by the ELISA test. Absorbance values were compared between the susceptible and resistance lines and correlation analysis was conducted to determine whether there was any association between absorbance intensity and degree of resistance.

Screening the Beta maritima core collection for resistance to BSBMV - The USDA *Beta* germplasm collection is maintained in Pullman, Washington. The core collection of *Beta maritima*, which contains approximately sixty accessions from around the world, was obtained from the collection curator and screened for resistance to BSBMV. Seed from each accession were planted in soil infested with BSBMV and then the plants were grown, under conditions conducive for virus infection, for ten weeks. After this period of baiting, plants were harvested and tested by ELISA for infection by BSBMV. There were seven replications of each accession in each of two separate tests.

Irrigation Study: Sugar beet varieties Kojak and Ranger were planted at a rate of 7 seeds per foot on April 1, 1999. Irrigation was supplied by a center pivot irrigation system, with 60" drops equipped with LEPA nozzles. Three irrigation treatments were implemented during the growing season (2.5" every week, 2.5" every other week and 5.0" every third week). On September 9, plots were harvested. Sugar beets were topped, weighted, given a disease rating, and percent sucrose was determined.

Results

Interactions between BNYVV and BSBMV- To date, three sets of soil samples have been planted and one harvested. The intensively sampled field in which plant samples were taken was the first field to be tested. Plant samples collected from the variety test displayed obvious systemic symptoms of BSBMV and typical symptoms of BNYVV infection also, but when the collected root samples were tested by ELISA, no samples tested positive for either BSBMV or BNYVV. The test was repeated and again no positive samples were obtained. Because of the prevalence of systemic symptoms on the plants that were sampled, we tested the plants a third time, but used the Western Blot test. Results were positive and 96% of the plants tested positive for BSBMV but less than one percent tested positive for BNYVV alone. Sixteen percent tested positive for both BNYVV and BSBMV. When we harvested bioassay plants from the soil samples taken from the same plots, results were opposite those of the field grown plants tested by Western Blot analysis. Thirty eight percent of the bioassay plants tested positive for BNYVV and but only two percent tested positive for BSBMV.

Results of these studies seem contradictory, but in fact they are not and they provide an important hint to the interactions between BSBMV and BNYVV. It appears from these results that BNYVV infects first during the season but by the end of the season, BSBMV has dominated in the competition. This explains why BSBMV was the predominant pathogen in the field sampled beets, harvested at the end of the season, but BNYVV was predominant in the 10-

week-old bait plants. The results of this study support previous greenhouse studies where BSBMV was dominant over BNYVV in dual infection studies.

BNYVV germplasm resistance to BSBMV - Results of this year's repeated study, corroborated those from a preliminary study conducted in 1998. Cultivars with resistance to BNYVV are totally susceptible to BSBMV and there is no correlation between the degree of resistance to BNYVV and the virus titre of BSBMV in infected plants (Table 1). Since most genetic resistance to BNYVV is, at present, based on the Holly resistance gene, it is unlikely that any BNYVV resistant cultivars will possess significant resistant resistance to BSBMV. Therefore, if recombination between BSBMV and BNYVV occurred, current varieties resistant to BNYVV might become susceptible. Furthermore, all current sugar beet varieties are susceptible to BSBMV and a particularly virulent isolate could cause significant disease loss. Even a mild isolate, in the presence of extremely wet soil conditions, might cause significant losses in quality and root yield.

Table 1. 1999 BNYVV/BSBMV Susceptibility Study

Cultivar	% BNYVV Resistance	O.D.	ANOVA
Beta 4035 R	90	0.354	NS
Beta 4038 R	90	0.229	NS
Beta 4006 R	90	0.579	NS
Beta 1399	0	0.597	NS
Maribo 9372	0	0.08	NS
Seedex 705	75	0.271	NS
Kojak	50	0.096	NS
Monohy 970601101	100	0.085	NS
Monohy 9706035201	100	0.316	NS
Monohy 9706047501	50	0.623	NS
Monohy 9706047601	75	0.089	NS
Monohy 9706047801	75	1.009	NS
Monohy 9706048201	50	0.308	NS
Monohy 9706048301	50	0.105	NS
Monohy 9804011001	0	0.51	NS
Monohy 9806003701	100	1.15	NS
Monohy 9155	0	1.351	NS
Monohy 9255	0	1.183	NS
Monohy RH3	0	0.093	NS
Monohy 1639	100	0.279	NS

Correlation Coefficient = -0.14 NS

Screening the Beta maritima core collection for resistance to BSBMV - Approximately 60 accessions from the *Beta maritima* core collection were screened for resistance to BSBMV. Two accessions were identified, 546417 from France and 546404 from the Netherlands, that appear to have significant resistance to the virus. In both accessions, none of the test plants tested positive for BSBMV in the two repeated tests. There were seven replications in each test so the odds of negative results due to escape from infection are minimal.

Irrigation Study - Environmental conditions were particularly wet this year, making this a difficult year for imposing differential irrigation treatments. Only in the later part of the growing season we were able to impose a limited irrigation treatment that had a significant effect in controlling disease incidence. Table 2 summarizes the results obtained from the study. Regardless of the irrigation treatment Kojak had significantly higher disease incidence than Ranger. Both varieties, however, had less disease when grown under limited irrigation. Although no significant yield differences were found between the two varieties, Ranger had the tendency to yield more than Kojak. Percent sugar, on the other hand, was significantly higher in Ranger under full irrigation. Limited irrigation did not reduce yield or percent sugar in either variety.

Table 2.

Variety	Full Irrigation			Limited Irrigation		
	Disease Rating	Yield Tons/ac	Sugar %	Disease Rating	Yield Tons/ac	Sugar %
Kojak	4.0 A a	19.4 A a	13.7 A a	2.4 A b	17.4 A a	14.3 A a
Ranger	2.6 B a	26.8 A a	14.2 B a	1.4 B b	23.6 A a	14.4 A a

Means followed by the same upper case letter within a column are not significantly different.
Means followed by the same lower case letter within a row are not significantly different.

Discussion

Results of the field grid sampling study verified that interactions occur between BNYVV and BSBMV and that BSBMV becomes dominant over BNYVV as the season progresses. However, our greenhouse study suggests that BNYVV infects plants first (it may be able to infect plants at a cooler soil temperature) and therefore is able to cause severe disease even though BSBMV eventually dominates the infection. We have not completed SSCP analysis of the samples yet and do not know whether the interaction between BNYVV and BSBMV includes recombination or not.

If recombination does occur between BNYVV and BSBMV it is impossible to predict whether a hybrid strain that can infect BNYVV resistant cultivars and cause significant disease will develop or not. To date, all BNYVV resistant cultivars tested have been susceptible to BSBMV. Nearly all these cultivars possess the Holly resistance gene, so our base for genetic resistance is very narrow. We know that recombination is common among RNA viruses and since BNYVV and BSBMV are so genetically similar and are often together in a single infection in the field, recombination is likely instead of just possible. As a precaution, breeders should begin to identify and incorporate BSBMV resistance into breeding lines for quick introduction into cultivars. Results of our BSBMV screening study are encouraging because two and possibly three *Beta maritima* accessions tested negative for BSBMV infection in two well replicated studies. It will be important to determine whether these accessions have any affect on infection by BNYVV.

The field where the irrigation study was conducted was infested by numerous soilborne pathogens, including R*hizoctonia, Fusarium, Aphanomyces,* BNYVV and BSBMV. Reduced irrigation reduced disease incidence that resulted in yields equal to those in higher irrigation plots. However, Ranger, a BNYVV susceptible cultivar, yielded better than Kojak, which is resistant to BNYVV. This demonstrates that when a BNYVV tolerant cultivar is grown in a field infested with multiple pathogens, tolerance to BNYVV may be of secondary importance to the other pathogens in the field. BNYVV resistant cultivars are the best means of managing rhizomania but growers must be prepared to use additional disease management strategies if the field is infested with more than BNYVV.

SUGARBEET RESEARCH

1999 Report

Section G

Molecular Plant Pathology Laboratory

Agricultural Research Service

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CONTENTS

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Smigocki, A.C., S. Heu, C. Wozniak and G. Buta. Insecticidal acitivity in leaves transformed with a plant growth hormone biosynthesis gene *ipt*. ACTA Physiol. Plant. (submitted)

Mujer, C.V. and A.C. Smigocki. Wound-inducible cytochrome P-450 from *Nicotiana plumbaginifolia*. Physiol. Plant. (submitted)

Wilhite, S.E., T.C. Elden, V. Puizdar, S. Armstrong and A.C. Smigocki. Inhibition of aspartyl and serine proteinases in the midgut of sugarbeet root maggot with proteinase inhibitors. Entomologia Experimentalis et Applicata (in press).

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Wilhite, S.E., T. Elden and A.C. Smigocki. Molecular cloning of a cDNA that encodes a cathepsin L-like cysteine proteinase from alfalfa weevil (*Hypera postica*) midgut. GenBank Accession Number AF157961, 1999.

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Selected abstracts of papers published or approved for publication:

BIOTECHNOLOGICAL STRATEGIES FOR EFFECTIVE CONTROL OF THE SUGARBEET ROOT MAGGOT (*TETANOPS MYOPAEFORMIS* RODER).

Smigocki*, Ann[1], Stephen Wilhite[2], Tom Elden[2], Scott Armstrong[3] and Chris Wozniak[1,4], [1]Molecular Plant Pathology Laboratory, [2]Soybean and Alfalfa Research Laboratory, ARS, USDA, Beltsville, MD 20705, [3]Department of Entomology, North Dakota State University, Fargo, ND 58105 and [4]Biopesticide and Pollution Prevention Division, US Environmental Protection Agency, Washington, D.C. 20460

Two approaches are being undertaken for management of the most devastating pest of sugarbeet in the US, the sugarbeet root maggot (SBRM). One approach involves the expression in transgenic sugarbeet plants of proteinase inhibitor genes which have specific activity against the root maggot's digestive proteases. These enzymes are essential for the release of nutrients for normal growth and development. Extracts of midguts excised from feeding second instar larvae were analyzed for specific protease classes using an inhibition assay. More than 86% of the gut protease activity was inhibited by 2 mM phenyl methyl sulfonyl fluoride, a serine protease inhibitor. Less than 3% inhibition was observed with 50 μM E-64, a cysteine protease inhibitor, and no inhibition with Pepstatin A, an aspartyl protease inhibitor. Using azocasein as a substrate, maximum protease activity was detected at pH 8.5, consistent with the serine class of proteases. Another approach being evaluated is the effect of cytokinin-induced insecticidal compounds on the SBRM larvae. A 1% suspension of leaf surface extracts from *Nicotiana plumbaginifolia* plants transformed with a cytokinin biosynthesis gene induced a twitching response and death of 30% of the first instar SBRM larvae at 72 hr. After 120 hr, 92% of the larvae were dead as compared to about 25% of the controls. Sugarbeet plants transformed with the cytokinin biosynthesis gene fused to a wound-inducible or a tuber-specific promoter have been regenerated for further analysis of the effect of cytokinins on defense responses.

CARBOHYDRATE CONTENT OF SUGARBEET (*BETA VULGARIS* L.) TRANSFORMED WITH A CYTOKININ BIOSYNTHESIS GENE.

Snezana Ivic[1], Iris McCanna[1], Richard Sicher[2] and Ann Smigocki[1] [1]Molecular Plant Pathology Laboratory, [2]Climate Stress Laboratory, ARS, USDA, Beltsville, MD.

To study the role of cytokinins in carbon partitioning, sugarbeet clone Rel-1 was transformed with the isopentenyl transferase *ipt* gene fused to a wound-inducible proteinase inhibitor II (Pin2) or a tuber-specific patatin (Pa) gene promotor. Two transformation methods were used, *Agrobacterium*-mediated cotyledon transformation and particle bombardment of embryogenic hypocotyl callus. For root initiation, transformed shoots had to be exposed to high auxin concentrations (50 mg IBA/l) for 24 hours as compared to normal shoots that were maintained on 3 mg IBA/l. *Ipt* shoots rooted in 4-8 weeks and the controls in 2 weeks. All *ipt*-transformed plants exhibited phenotypic characteristics associated with elevated cytokinin levels. Some showed

increased adventitious shoot formation while others had reduced apical dominance, a large, proliferative crown and a very small root mass. Others exhibited slower growth and an overall reduction in the number and size of leaves. Leaf and taproot cytokinin levels were up to 17 and 2 times higher, respectively, than in normal plants. In one transformant, about a 9 fold increase in leaf sucrose levels was observed while the glucose content was 18 times higher. No corresponding increase in sucrose and glucose levels was observed in the taproots of this plant.

INHIBITION OF ASPARTYL AND SERINE PROTEINASES IN THE MIDGUT OF SUGARBEET ROOT MAGGOT WITH BIOCHEMICAL AND PLANT-DERIVED PROTEINASE INHIBITORS. Stephen E. Wilhite[1], Thomas C. Elden[1], Borut Strukelj[2], Scott Armstrong[3], and Ann C. Smigocki[4] [1]Soybean and Alfalfa Research Laboratory, Agricultural Research Service, U.S. Department of Agriculture, Beltsville, MD 20705, USA, [2]Department of Biochemistry and Molecular Biology, Jozef Stefan Institute, Jamova 39, SI-1000, Ljubljana, Slovenia, [3]Plant and Soil Sciences Department, Texas Tech University, Lubbock, TX 79409, USA, [4]Molecular Plant Pathology Laboratory, Agricultural Research Service, U.S. Department of Agriculture, Beltsville, MD 20705, USA.

The use of genes encoding proteinase inhibitors (PIs) to transform crop plants for resistance to insect pests (see Jouanin et al., 1998, and; Schuler, et al., 1998, for reviews) may represent an alternative approach to insect control. PIs occur naturally in a number of plant species and are likely a part of the natural defense mechanism against insects (Green & Ryan, 1972). PIs specifically bind and inhibit the action of digestive proteinases in the insect midgut, thereby exerting a deleterious effect on insect growth and development (Jongsma & Bolter, 1997, for review). Due to significant variation in the types and properties of proteinases utilized by insects for dietary purposes (see Terra & Ferreira, 1994, for a review), and the altered specificity that plant PIs possess toward such proteinases (Keilova & Tomasek, 1976; Abe et al., 1994; Brzin et al., 1998; Christeller et al., 1998; Pernas et al., 1998), it is necessary to characterize the proteolytic activities of each individual pest species in order to devise a rational control strategy. The present study examines the effect of pH, low-molecular weight inhibitors, and plant-derived PIs on general substrate hydrolysis to identify the major midgut proteinases of the SBRM.

WOUND-INDUCIBLE CYTOCHROME P450 FROM NICOTIANA PLUMBAGINIFOLIA. Cesar V. Mujer and Ann C. Smigocki Molecular Plant Pathology Laboratory, Agricultural Research Service, U.S. Department of Agriculture, Beltsville, MD 20705, USA.

Two Nicotiana plumbaginifolia cDNA clones, CYP72A2 and npl2, with high sequence similarity to cytochrome P450 monooxygenases were isolated using reverse transcription-polymerase chain reaction. CYP72A2 has an open reading frame of 1524 nucleotides and its deduced 508 amino acid sequence has 45% identity to Catharanthus

roseus P450 CYP72A1. npl2 is similar to CYP72A2 except for an 82-nucleotide deletion within its coding region and an internal stop codon. Southern blot analysis indicated that there are at least three copies of the CYP72A2 gene and that they are induced by mechanical wounding, insect chewing (Manduca sexta) and cytokinin application. In N. plumbaginifolia plants transformed with a wound-inducible cytokinin biosynthesis gene construct (PI-II-ipt), mechanical wounding of the leaves induced a 6-fold increase of CYP72A2 messages at 6 h in comparison to a 2-fold induction after 12 h in wounded, untransformed leaves. A similar response was observed when plants were sprayed with 5×10^{-5} or 5×10^{-6} M zeatin or when M. sexta larvae fed on the leaves. The response to feeding larvae and wounding was systemic. Using polyclonal antibodies raised against three internal regions of the deduced CYP72A2 protein, a 58.8 kDa polypeptide was detected in leaves of N. plumbaginifolia as well as in the leaves of 4 other plant species. The modulation of CYP72A2 expression by cytokinins and the possible role of P450 in plant defense responses are discussed.

INHIBITION OF CYSTEINE AND ASPARTYL PROTEINASES IN THE ALFALFA WEEVIL MIDGUT WITH BIOCHEMICAL AND PLANT-DERIVED PROTEINASE INHIBITORS. Stephen E. Wilhite[1], Thomas C. Elden[1], Joze Brzin[2], and Ann C. Smigocki[3] [1]Soybean and Alfalfa Research Laboratory, Agricultural Research Service, U.S. Department of Agriculture, Beltsville, MD 20705, USA, [2]Department of Biochemistry and Molecular Biology, Jozef Stefan Institute, Jamova 39, SI-1000, Ljubljana, Slovenia, [3]Molecular Plant Pathology Laboratory, Agricultural Research Service, U.S. Department of Agriculture, Beltsville, MD 20705, USA.

Proteolytic activities in alfalfa weevil (*Hypera postica*) larval midguts have been characterized. Effects of pH, thiol activators, low-molecular weight inhibitors, and PIs on general substrate hydrolysis by midgut extracts were determined. Hemoglobinolytic activity was highest in the acidic to mildly acidic pH range, but was maximal at pH 3.5. Addition of thiol-activators DTT, 2-ME, or L-cysteine had little effect on hemoglobin hydrolysis at pH 3.5, but enhanced azocaseinolytic activity two to three-fold at pH 5.0. The broad cysteine proteinase inhibitor E-64 reduced azocaseinolytic activity by 64% or 42% at pH 5 in the presence or absence of 5 mM L-cysteine, respectively. Inhibition by diazomethyl ketones, Z-Phe-Phe-CHN_2 and Z-Phe-Ala-CHN_2, suggest that cathepsins L and B are present and comprise approximately 70% and 30% of the cysteine proteolytic activity, respectively. An aspartyl proteinase component was identified using pepstatin A, which inhibited 32% (pH 3.5, hemoglobin) and 50% (pH 5, azocasein) of total proteolytic activity. This activity was completely inhibited by an aspartyl proteinase inhibitor from potato (API), and is consistent with the action of a cathepsin D-like enzyme. Hence, genes encoding PIs with specificity toward cathepsins L, B and D could potentially be effective for control of alfalfa weevil using transgenic plants.

Gene Transfer to Optimize the Sucrose Storage Capacity of the Sugarbeet Taproot

BSDF Project 810

Ann C. Smigocki

Changes in phytohormone profiles of sugarbeet taproots between sowing and harvest have been determined and related to initiation of cambia, cell division of the cambia and rapid cell expansion stages in root development. It is well established that cytokinins induce cell division and, in taproot-derived sugarbeet suspension cultures, cytokinin levels were shown to peak just prior to cytokinesis. These results suggest that higher cytokinin levels in the taproot will lead to increased cell division, additional vascular rings and increased sucrose yield. In addition, cytokinins have been identified as having functional significance in the control of assimilate movement in plants, particularly by altering phloem unloading, sink initiation, and sink strength and capacity.

Higher endogenous cytokinin levels are anticipated to increase the sink activity of the taproot leading to an increase in the overall root productivity and a decrease in the leaf sucrose storage pools. The removal of more sucrose at the source may also decrease the feedback inhibition on the system and might be expected to increase the maximum rate of photosynthesis. Additionally, increasing cell division and the number of vascular rings in the taproot is expected to produce a low-tare sugarbeet with globe-shaped storage root with fewer branches or grooves. A low-tare sugarbeet would be of great benefit to the farmers, processing plants and the environment.

Since field applications of phytohormones are of limited value due to high costs and rapid degradation, we have genetically engineered sugarbeets for production of high cytokinin

levels in the taproot. To increase endogenous cytokinins in the taproot, a bacterial cytokinin biosynthesis gene *ipt* was fused to a tuber-specific promoter from the patatin gene of potato and introduced into sugarbeet using the method of particle bombardment of embryogenic hypocotyl and cotyledon callus. Leaf zeatin riboside concentration in two independent transformed lines was up to 18-fold higher than in the control, while a corresponding 2-fold increase was observed in the taproots. Elevated cytokinin levels were associated with distinguishable morphological alterations that are commonly seen in *ipt* transformants, i.e. reduced root growth and leaf surface area and adventitious shoots development. Leaf concentrations of major carbohydrates, sucrose, glucose and starch were not significantly different from the control plants. Taproots of mature (8-12 month) transgenic plants were greatly reduced in size and had lower carbohydrate concentrations as compared to the controls. However, sucrose concentrations in young (5 month) taproots of two of the transformants were elevated in comparison to the untransformed control. These preliminary results support the hypothesis that higher cytokinin levels may enhance sucrose accumulation in younger taproots but become detrimental to normal development as the plant matures.

Engineering sugarbeets with multiple proteinase inhibitor genes for enhanced tolerance to the sugarbeet root maggot

BSDF Project 811

Ann C. Smigocki

The sugarbeet root maggot (SBRM) *Tetanops myopaeformis* von Röder (Diptera: Otitidae) was first described as a sugarbeet pest in Utah in the 1920's. It is now considered the major sugarbeet pest of the central and western sugar-beet-growing areas in the United States and Canada. More than half of the U.S. sugarbeet fields are infested. Developing SBRM larvae feed on roots throughout the growing season, inflicting significant crop damage and yield losses as high as 23%. Control has come primarily through the application of pesticides to sugarbeet fields in order to reduce larval populations. Cultural control practices, such as crop rotation, are made difficult by the mobility of the adult flies, and the existence of several weed species as alternate hosts hinders population control. Currently no biological control measures are available. In the next few years all chemical pesticides effective against the maggot will likely be removed from EPA approved registrations. Therefore, an urgent need exists to develop effective, environmentally safe approaches to target this pest.

The use of genes encoding proteinase inhibitors to transform crop plants for resistance to insect pests represents an alternative approach to insect control. Proteinase inhibitors occur naturally in a number of plant species and are likely a part of the natural defense mechanism against insects. Proteinase inhibitors specifically bind and inhibit the

action of digestive proteinases in the insect midgut, thereby exerting a deleterious effect on insect growth and development. Due to significant variation in the types and properties of proteinases utilized by insects for dietary purposes, and the altered specificity that plant proteinase inhibitors possess toward such proteinases, it is necessary to characterize the proteolytic activities of each individual pest species in order to devise a rational control strategy.

Latest studies on inhibition of insect protease activities by proteinase inhibitors indicate that a combination of inhibitors incorporated into insect diets is more toxic at levels where individual inhibitors are not toxic. In addition, higher levels of more than one proteinase inhibitor have been found in insect resistant vs. susceptible plants. Therefore, introduction of multiple proteinase inhibitor genes into transgenic plants will most likely prove to be the most effective and perhaps sustained means of controlling insect infestations.

We examined the effect of pH, low-molecular weight inhibitors, and plant-derived proteinase inhibitors on general substrate hydrolysis to identify the major midgut proteinases of the SBRM. We dissected out midguts from feeding second instar sugarbeet root maggot larvae that were collected in St. Thomas, ND in the summer of 1998. Major classes of digestive proteinases were identified. Proteolytic activity in larval gut extracts peaked at pH 2.5 and 9.5. Addition of low-molecular weight biochemical inhibitors targeting three major classes of insect digestive proteinases revealed that Pepstatin A, an aspartly proteinase inhibitor, was by far the most effective inhibitor at pH 3.0 (83.9% inhibition). A cysteine proteinase inhibitor, E-64, which has high potency toward virtually all known cysteine proteinases had only minor inhibitory activity (6.5%). At pH

8.5, treatment with PMSF inhibitor resulted in a sizable decrease in proteolysis (47.3% inhibition) suggesting that serine proteinases are major contributors to proteolysis at the higher pH. Proteinase inhibitors purified from plants were also tested. Squash aspartyl proteinase inhibitor (SQAPI) blocked virtually all the proteolytic activity at pH 3.0, thus confirming the importance of the aspartyl class at acidic pH. Soybean trypsin-chymotrypsin inhibitor (Bowman-Birk inhibitor I) blocked nearly all proteolysis at pH 8.5, suggesting the presence of trypsin and/or chymotrypsin-like serine proteinases in the extract. Overall, our results indicate that majority of the digestive enzymes found in the actively feeding maggot midguts are aspartyl and serine proteases with a relatively small portion of the activity being associated with cysteine proteases.

Bioengineering Sugar Beets for Disease Resistance

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Sugar beets, long regarded as recalcitrant for both DNA transformation and plant regeneration from individual transformed cells, two essential prerequisites for biotechnological improvement of the crop, could theoretically benefit from 21st century science. Snyder, Ingersol, Smigocki & Owens (1999) reported transgenic sugarbeets carrying *ipt*, an agrobacterial cytokinin gene, which may influence insect pest susceptibility and ones encoding antimicrobial peptides that could enhance resistance to pathogens.

Using methodology as described in the 1998 BSDF Annual Report, we have since identified two transgenic sugar beet clones as candidates for having improved leafspot resistance due the expression of introduced antimicrobial protein gene(s). Unlike all of the other clones examined, they have some ability to inhibit the growth of *Cercospora beticola,* the fungus that causes leafspot disease. In the majority of the U.S. sugar beet -growing acreage, leafspot reduces both yield and sucrose percentage by as much as one third or more. Reverse transcriptase polymerase chain reaction, called RT/PCR, is being used to measure the expression of the introduced genes. For determining either the biological or potential agronomic significance, these new sugar beet genotypes have been vegetatively propagated with the plan of examining a number of healthy greenhouse-grown plants for their ability to resist foliar germination of *C. beticola* spores.

Supported in part by this BSDF project, Joe Saunders of MSU, East Lansing, MI, has recently visited Beltsville to transfer methodologies for clonal selection and regeneration. Growing out of this was a newly devised method of incubating embryogenic callus of sugar beet

under light on a rotary shaker in medium containing the appropriate growth regulator and μM quantities of cercosporin to select for resistance. Toxin resistant shoots can develop in 14 days.

Since only a low efficiency of transformation and regeneration is available and since resources are limited, we must therefore carefully choose which bioengineered, disease-resistance-conferring genes to introduce into sugar beet. Dr. Bob Davis, RL of MPPL, has obtained Agriculture Research Service funding to support a postdoctoral researcher to use viral vectors to study gene expression in transfected sugar beet lines, a new approach deserving careful attention.

Since 1998, when this project was first initiated as BSDF #830, a new approach actively underway at Beltsville, Maryland has been aimed at the genetic transfer into sugar beet of a bioengineered *cfp* gene from *Cercospora* generously supplied by Greg Upchurch of Raleigh, NC. The laboratory construct we have generated places *cfp* under the control of the stress-inducible Ubi7 promoter from potato, courtesy of Bill Belknap of Albany, CA. Following the suggestion of Dr. Roger Lawson, we needed an ARS-owned non-proprietary promoter and Ann Smigocki suggested Ubi7. Belknap provided the 1.7kb Ubi7 promoter (NCBI accession number stu26813) as a *gus* reporter gene fusion in pUC19, an *E.coli* plasmid vector. *Bam*H1 restriction enzyme digestion was used to liberate the intron-carrying (prevents expression in bacteria) Ubi7 promoter from both the *gus* fusion and from the pUC19 vector. Purified restriction fragment was ligated to *cfp* (NCBI accession number AFO91042) carried on pBS, another *E. coli* cloning vector, and then the ligation mix was used to transform competent cells of *E.coli* strain DH5α. Among the transformants, clones carrying the Ubi7 promoter fused immediately upstream of the *cfp* gene were identified and then the exact orientation of the insert DNA was experimentally ascertained by multiple enzyme restriction analysis. Now, the desired gene fusion are being inserted into an *Agrobacterium* Ti-based vector so that transformation of sugar beets can then be performed. Ann

Smigocki plans to cooperate in the latter stages. Since the cell-killing, lesion-forming cercosporin toxin is presumed with justification to be a virulence factor, it is hoped that transgenics carrying the Ubi7/*cfp* construction will possess a degree of immunity from the *Cercospora beticola*-induced infection and destruction of mature sugar beet leaves.

Three species of fluorescent *Pseudomonas* were isolated from cultures enriched from the rhizosphere of healthy plants have been bacteriologically cloned and biochemically characterized. One was determined by fatty acid (FA) analysis, done in collaboration with Jeffrey Buyer of the Soil Microbial Systems Lab, to be an isolate of *Pseudomonas syringae*. Two other species, one named *P. corrugata* and another an unidentified *Pseudomonas*, related to *P. putida, P. chlororaphis*, *P. corrugata*, *P.migule*, and *P. veronii*. On the basis of FA analysis alone, it appears to be entirely new to bacteriology. The *P.corrugata* and the new *Pseudomonas* species were clearly demonstrated for the first time to produce antibiotics against *Cercospora beticola.*

Figure 1. *Cercospora* on left is strongly inhibited by diffusable substances or antibiotics produced by the new *Pseudomonas* on right.

Pseudomonas spp. strain ND9L will be subjected to 16S RNA sequence analysis to determine phylogenetic relationships of the new species. This is important since these bacteria could be valuable new sources of *Cercospora*-killing genes for sugar beet bioengineering.

In summary, in this first year of SBDF project #831, several new sugar beet bioengineering stratagies for controlling *Cercospora* were pursued: (1) the pathogen-derived gene *cfp,* conferring resistance to the probable virulence factor cercosporin toxin, has been modified *in vitro* to enhance *in vivo* expression in transgenic sugar beets and confer resistance, (2) together with Joe Saunders, a new method of directly selecting cercosporin resistant cell lines *in vitro* was devised, and (3) beneficial, plant-associated *Pseudomonas* species that exhibit potent antagonism of virulent pathogenic strains of *Cercospora beticola* were discovered and at least one, evidently a new species, could prove to be useful for effectively controlling leafspot when sprayed as a biofungicide either before or during periods of predicted *Cercospora* outbreak. Collaboration with Dr. John Weiland of Fargo, ND is important to implement this latter approach.

Although the bacterial genes involved have yet to be identified or isolated, the construction of sugar beet transgenics that carry the anti-*Cercospora* genes from *Pseudomonas* could be a promising approach if sufficient time and funding permit.

We thank Dr. Garry Smith and John Eide for mining the rhizosphere bacteria.

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Characterization of a Fungal Pathogen of the Sugarbeet Root Maggot
BSDF Project 850

Chris A. Wozniak
(Ann C. Smigocki, Michael R. Marshall)

Publications: Hodge, K.T., Humber, R.A. and Wozniak, C.A. *Cordyceps variabilis* and the genus *Syngliocladium*, Mycologia 90:743-753, 1998.
U.S. Patent US05955071, Fungal Species for the Biological Control of the Sugarbeet Root Maggot, C.A. Wozniak, USDA-ARS; issued 9/21/99.

Abstract: Wozniak, C.A., A novel fungus pathogenic to the sugarbeet root maggot, J Sugarbeet Research 36(3):98, 1999.

Progress Report: As part of an ongoing project to develop biological control agents for management of the sugarbeet root maggot, this project seeks to characterize the fungus *Syngliocladium tetanopsis*. Following its discovery in 1994 in the Red River Valley, *S. tetanopsis* has been assayed for pathogenicity toward the sugarbeet root maggot (SBRM) through *in vitro* assays. All isolates collected (*i.e.*, > 30) have proven infective to SBRM when evaluated against third instar larvae and mortality has been as high as 96 % (n=120) with some isolates. This fungus represents a new species of *fungi imperfecti*; the teleomorphic stage is currently unknown.

Current objectives for research on this agent include the refinement of culture conditions to enhance the rate and quantity of spore production, assess the viability of spore preparations through fluorescent cellular probes, and to determine the host range of *S. tetanopsis*.

In order to develop this fungus for commercial use, attention is paid to the economics of scale-up, including the culture medium needed for spore production. Highly infective spore preparations have been produced using a modification of an oatmeal medium (OatM) as used in standard mycology applications. Although spore yield is high, it would be advantageous to speed up the rate of production. With this in mind, several added sources of organic nitrogen were evaluated for their effects on cultural morphology and growth rate. On OatM, colony morphology is largely restricted to small constricted colonies with a smooth edge and few aerial hyphae. Conidiophores are borne directly on surface hyphae in slime droplets and ultimately on aerial synnemata. Spores from both sources are identical in morphology and they give rise to identical colony types when subcultured; both are also infective to SBRM.

In contrast, when yeast extract, tryptone, casein, potato extract, tomato extract, or complex mixtures of peptone and corn meal with various plant-based carbohydrates were used to amend media, spore production was severely inhibited. Additionally, aerial hyphae and synnemata were absent with a drastically different cultural morphology resulting. It is clear that this species is highly pleomorphic and capable of responding to a variety of nutritional components. Based

upon previous work with alteration of atmospheric conditions of culture (*e.g.*, CO_2, N_2, low O_2) and the current observations, this species is capable of a dimorphic growth habit. While not representing the desired effect (*i.e.*, enhanced spore production), the net growth rate of fungal colonies was greater than with OatM.

Interestingly, of the three isolates evaluated in these studies on media components, one showed a complete lack of growth on modified Sabauraud medium, while the other two showed significant growth, but a lack of sporulation. This suggests that considerable diversity exists within the population(s) of *S. tetanopsis* isolated from Minnesota and North Dakota. Studies on the virulence of these strains toward SBRM will also emphasize examining as many strains as possible to select for variance in these characters.

A lack of spore production was also noted when liquid shake cultures of *S. tetanopsis* were initiated in soy and beef protein digests, although again, the rate of biomass production was rapid. A medium typically used for culture of insect cells was also inoculated with conidiospores of *S. tetanopsis* for assessment of spore production. This medium is rich in animal serum proteins and vitamins, as well as buffering salts. Vegetative growth was observed to progress more rapidly than with potato dextrose broth, however, no spores were observed even after extended culture. A medium consisting of homogenized meal worm larvae was also inoculated with conidiospores to assess the impact of complex insect constituents on growth, however, *S. tetanopsis* grew poorly on this substrate.

Measurements of saline spore suspensions from OatM plates indicated that spore viability was low as measured by hydrolysis of fluorescein diacetate (FDA) by membrane-bound esterases. Serial dilutions onto OatM indicated that spore germination was significantly higher than predicted from FDA measurements, however. Use of FDA and a derivative, carboxyfluorescein diacetate, succinimidyl ester, indicates that these previous assessments of fluorescence may be flawed in that the pH and possibly the ionic strength of the suspending medium were minimizing observed fluorescence. Newly generated protocols indicate that spore viability can be measured with these substrates by adjustment of pH (*i.e.*, increasing alkalinity) and reduction of ionic strength. Serial dilutions offer some information to assess viability, although it appears that there may be an inhibitor of germination present in the spores in that dilutions (plate counts) are non-linear. Further efforts will address this phenomenon to develop a simple and rapid assay for determination of viability.

Work with cryopreserved spore and mycelial preparations determined that viability could be maintained for at least 16 months at -80°C. More relevant, however, is the stability of preparations as would be typical of biopesticidal products (*i.e.*, shelf-life at room temperature or under refrigeration). Cultures dried under ambient conditions have yielded viable spores after 8 months, although quantitation was not possible at the time of assay. Somewhat surprisingly, spore preparations maintained in 0.85 % saline for 5 months at room temperature yielded viable colonies when plated onto OatM. These findings suggest that spore stability over time may not be a limiting factor in development of a commercial formulation. These experiments will be repeated once the details of the fluorescence viability assays are completed.

While not being pathogenic to the coleopteran, lepidopteran or neuropteran species examined so far, it is plausible that other dipteran species may be within the host range of *S. tetanopsis*. Other members of this genus have been found on flies unrelated to the SBRM. Both *Drosophila melanogaster*, the common fruit fly, and *Musca domestica*, the house fly, are currently being examined for susceptibility to this fungus. Preliminary data indicate that these species are not detrimentally affected by treatment with conidia of *S. tetanopsis*, however, variables associated with the culture of these flies *in vitro* complicate this assessment. More work will be needed to determine this unequivocally. Contacts have also been made with other ARS researchers to test other dipteran species that are considered pests with spore preparations for evaluation of host range.

A recent press release on some of this work by the USDA/ARS Information Staff has garnered some commercial interest in this fungus for root maggot control. Arrangements are being made to share cultures with interested parties and further the evaluation of this potential biopesticide. It is proposed that with the appropriate formulation technology, this agent could be evaluated in the 2001 growing season under field conditions. Most likely this agent would be applied as a granular in-furrow at planting or as a seed coating treatment. Collaborative efforts have been established with ARS and University researchers to evaluate this agent under field conditions of high maggot infestations.

SUGAR BEET RESEARCH

1999 REPORT

Section H

University of Illinois
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BEET SUGAR DEVELOPMENT FOUNDATION
Research Report 2000

New Strategies for Modifying Sucrose Distribution in Sugarbeet

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The proton-coupled sucrose transport protein mediates the key step in the long-distance transport of newly synthesized sucrose from the leaf to the taproot for storage. While determining how this protein works, we discovered a modified version of the transporter that is 15-fold more active than the wild-type (Lu and Bush 1998). The modified version of the transport protein is an excellent candidate for genetic engineering because it is capable of loading plant cells with molar concentrations of sucrose. Thus, directed expression of the "hyperactive" transporter in the taproot could be used to enhance sucrose accumulation by increasing the uptake capacity of the storage cells. One goal of this project is to test the hypothesis that directed expression of the sucrose transporter can modify sucrose accumulation.

The second aim of this project is to investigate further our recent discovery of a control pathway that regulates sucrose loading into the vascular system in the leaf (Chiou and Bush 1998). The vascular system mediates the long distance transport of sucrose from the photosynthetic cells in the leaf to the sucrose storage cells in the tap root. This was a very significant finding because loading the vascular system for sugar export from the leaf is the key step that determines how much sucrose is delivered to the tap root. Defining the biochemical steps involved in controlling sucrose distribution to the beet will allow us to develop new strategies for manipulating productivity (Bush 1999).

The goal of this project is to increase sucrose storage in the taproot using two approaches. In the first, we are developing transgenic methods to express the hyperactive sucrose transporter in new cells and tissues. The second approach is based on the hypothesis that determining the mechanism the plant uses to control sugar export from the leaf will allow us to develop biochemical and/ or biotechnological strategies to increase sucrose transport to the tap root.

Recent Progress

We have been working on the hyperactive form the sucrose transporter that we want to express in the tap root as a mechanism to increase sucrose loading. We have vectors and promoters that should drive expression in this organ. We are now developing collaborations with labs that routinely transform sugar beet to make transgenic plants. Although we generate transgenic Arabidopsis and tobacco using Agrobacterium, the methods for sugar beet are beyond the capability of my lab (beet requires cell culture and we do not have a "gene gun" to deliver the genes). Because beet transformation is moving forward slowly, we are using potato, which is an easily transformed plant with a large storage organ, to test the hypothesis that we can alter sugar accumulation by over-expressing the hyperactive transporter in a target tissue. This is a parallel

experiment that allows us to develop our materials and methods (vectors, growth analysis, measurement of sugars and photosynthesis) while waiting for transformed beets.

The objective of our investigation of the regulatory system that controls sugar export from the leaf is to identify the biochemical steps involved in modifying the sucrose transporters ability to load the vascular tissue of the plant. Our initial analysis of this system showed that it controls sugar allocation between photosynthetic tissues and "import-dependent" organs like the beet tap root (Chiou and Bush 1998). Using Western blot analysis, we recently showed that down regulation of sugar transport activity is the result of protein degradation where the transporter is removed from cells that load the leaf vascular system. In parallel with its turnover, we used nuclear run-offs to show that decrease transporter-mRNA abundance is the result of down-regulation of gene expression. These changes in transporter protein stability and synthesis (as reflected by mRNA abundance) occur within a few hours. Thus, it appears that dynamic regulation of sucrose transporter abundance in the vascular system controls sugar allocation. We are now testing different pharmacological agents as tools for identifying the signal-transduction pathways that participate in this complex control system

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[illegible] that allow us to [illegible] the materials and methods [illegible], growth analysis, [illegible] and [illegible] after testing for transformed lines.

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